# S E D A R

*Southeast Data, Assessment, and Review*

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# SEDAR 24
# South Atlantic Red Snapper

## Data Workshop Report

(Stock Assessment Report Section II)

June 25, 2010

(Corrected June 29, 2010 and July 30, 2010)

SEDAR is a Cooperative Initiative of:

The Caribbean Fishery Management Council
The Gulf of Mexico Fishery Management Council
The South Atlantic Fishery Management Council
NOAA Fisheries Southeast Regional Office
NOAA Fisheries Southeast Fisheries Science Center
The Atlantic States Marine Fisheries Commission
The Gulf States Marine Fisheries Commission

SEDAR
The South Atlantic Fishery Management Council
4055 Faber Place #201
North Charleston, SC 29405
(843) 571-4366

**Revision of June 29, 2010**: Correction of conversion value used when converting calculated mean weights in kg to pounds for discarded commercial handline data (Section 3.4.2). The previous version of the DW report listed an average weight of 0.6 pounds, this version corrects the value to 2.9 pounds.

**Revision of July 30, 2010**: Update and correction of the DW participant list (Section 1.3).

# Table of Contents

# 1 Introduction

## 1.1 Workshop Time and Place

The SEDAR 24 Data Workshop was held May 24-28, 2010, in Charleston, SC.

## 1.2 Terms of Reference

### Data Workshop Terms of Reference – SAFMC Approved March 5, 2010

1. Review stock structure and unit stock definitions and consider whether changes are required.
2. Review, discuss, and tabulate available life history information (e.g., age, growth, natural mortality, reproductive characteristics); provide appropriate models to describe growth, maturation, and fecundity by age, sex, or length as applicable. Evaluate the adequacy of available life-history information for conducting stock assessments and recommend life history information for use in population modeling. Provide a written description of the biological sampling programs.
3. Compare and contrast life history parameter recommendations between the Gulf and South Atlantic populations of red snapper, and consider whether greater consistency between assessments of Gulf and South Atlantic stocks is appropriate.
4. Evaluate expanded otolith sampling efforts conducted during 2009 and consider which samples are appropriate as indicators of fishery and population age structure. Consider whether revisions of growth models are justified based on these additional samples.
5. Review available research and published literature on discard mortality rates, considering efforts for red snapper and similar species from the Atlantic as well as other areas such as the Gulf of Mexico, and considering recommendations on discard mortality provided through SEDAR 7 (Gulf of Mexico Red Snapper). Provide estimates of discard mortality rates by fishery, gear type, depth, and other feasible strata. Include thorough rationale for recommended discard mortality rates. Provided justification for any recommendations that deviate from the range of discard mortality provided in available research and published literature.
6. Provide measures of population abundance that are appropriate for stock assessment. Consider and discuss all available and relevant fishery dependent and independent data sources. Document all programs evaluated, addressing program objectives, methods, coverage, sampling intensity, and other relevant characteristics. Provide maps of survey coverage. Develop CPUE and index values by appropriate strata (e.g., age, size, area, and fishery); provide measures of precision and accuracy. Evaluate the degree to which available indices adequately represent fishery and population conditions. Recommend which data sources are considered adequate and reliable for use in assessment modeling.

7. Review the application of pre-MRFSS recreational catch records in the SEDAR 15 benchmark assessment and recommend appropriate use of pre-MRFSS data for assessment of red snapper.
8. Characterize commercial and recreational catch, including both landings and discards in both pounds and number. Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector. Provide observed length and age distributions if feasible. Provide maps of fishery effort and harvest. Provide a written description of the discard sampling programs.
9. Review SEDAR 15 and SEDAR 7 approaches to selectivity of red snapper, post-SEDAR 15 evaluations of fishery selectivity patterns for Atlantic red snapper, and available length and age composition information to develop recommendations for addressing fishery selectivity in the assessment model. Specifically address the degree to which domed shape selectivity should be applied to hook and line fisheries.
10. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage.
11. Develop a spreadsheet of assessment model input data that reflects the decisions and recommendations of the Data Workshop. Review and approve the contents of the input spreadsheet by June 4.
12. No later than June 18, 2010, prepare the Data Workshop report providing complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report). Develop a list of tasks to be completed following the workshop

## 1.3 List of Participants

**SEDAR 24 Participants List**

**South Atlantic Red Snapper**

**Data Evaluation Workshop**
**May 24-28, 2010**
**Charleston, SC**

Chairman Dale Theiling, SEDAR 24 Coordinator

| Appointee | Function | Affiliation |
|---|---|---|
| **DATA WORKSHOP PANEL** | | |
| ***Data Management*** | | |
| Rob Cheshire | Data Compiler | SEFSC, Beaufort |
| ***Life History Workgroup*** | | |
| Jennifer Potts | Leader and Editor | SEFSC, Beaufort |
| Dan Carr | Rapporteur and Data Provider | SEFSC, Beaufort |
| Chip Collier | Data Provider | NC DMF, SAFMC SSC |
| Marcel Reichert | Data Provider | MARMAP, SAFMC SSC |
| *Eric Robillard | Data Provider | GA DNR |
| Janet Tunnell | Data Provider | FL FWCC |
| Dave Wyanski | Data Provider | SC DNR |
| Laurie DiJoy | Data Provider | SC DNR |
| ***Commercial Statistics Workgroup*** | | |
| Doug Vaughan | Leader and Editor | SEFSC, Beaufort |
| Stephanie McInerny | Rapporteur and Data Provider | NC DMF |
| Steve Brown | Data Provider | FL FWCC |
| *Julie Califf | Data Provider | GA DNR |
| Julie DeFilippi | Data Provider | ACCSP |
| David Gloeckner | TIP Data Provider | SEFSC, Beaufort |
| Jack Holland | Data Provider | NC DMF |
| Kevin McCarthy | Logbook Data Provider | SEFSC, Miami |
| David Player | Data Provider | SC DNR |
| ***Recreational Statistics Workgroup*** | | |
| Ken Brennan | Leader, Editor, & Headboat Data | SEFSC, Beaufort |
| Kathy Knowlton | Rapporteur and Data Provider | GA DNR |
| Richard Cody | Data Provider | FL FWCC |
| *Doug Mumford | Data Provider | NC DMF |
| Beverly Sauls | Data Provider | FL FWCC |
| Tom Sminkey | Data Provider | MRIP |
| Chris Wilson | Data Provider | NC DMF |
| Julia Byrd | Data Provider | SC DNR |

***Indices Workgroup***

| | | |
|---|---|---|
| Amy Schueller | Leader and Editor | SEFSC, Beaufort |
| Brian Linton | Rapporteur & Gulf RS Ass't Advice | SEFSC, Miami |
| Julie DeFilippi | Data Provider | ACCSP |
| Paul Spencer | Assessment Advice | AFSC |
| Jessica Stephen | Data Provider | SC DNR/MARMAP |

***Analytical Team Representative***

| | | |
|---|---|---|
| Kyle Shertzer | Lead Analyst and Model Editor | SEFSC, Beaufort |

***Fishery Representatives***

| | | |
|---|---|---|
| Steve Amick | Charter/Headboat GA | SAFMC SG AP |
| Zack Bowen | Charter/Headboat GA | SAFMC SG AP |
| Gregory DeBrango | Commercial, FL | SAFMC SG AP |
| David Crisp | Recreational, FL | Individual |
| Kenny Fex | Commercial, NC | SAFMC SG AP |
| Frank Hester | Industry Scientist | Industry Consultant |
| Rusty Hudson | Fishery Consultant | Directed Sustainable Fisheries, Inc. |
| Robert Johnson | Charter/Headboat N FL | SAFMC SG AP |
| Rodney Smith | Recreational, FL | SAFMC SG AP |

* panel members not attending the workshop

**APPOINTED OBSERVER**

| | | |
|---|---|---|
| Kevin Stokes | Data Process Evaluation | CIE |

**COUNCIL REPRESENTATIVES**

| | | |
|---|---|---|
| George Geiger | Council Member | SAFMC |
| Ben Hartig | Council Member | SAFMC |
| Charles Phillips | Council Member | SAFMC |

**COUNCIL AND AGENCY STAFF**

| | | |
|---|---|---|
| Myra Brouwer | Observer | SAFMC |
| John Carmichael | Observer | SAFMC/SEDAR |
| Rick DeVictor | Red Snapper Council Lead | SAFMC |
| Kari Fenske | Observer | SAFMC |
| Patrick Gilles | Observer | SEFSC |
| Rachael Lindsay | Administrative Support | SEDAR |
| Anna Martin | Observer | SAFMC |
| Julie Neer | Observer | SEDAR |
| Andy Strelcheck | Observer | SERO |
| Gregg Waugh | Observer | SAFMC |
| Erik Williams | Observer | SEFSC, Beaufort |

**OBSERVERS**

Joseph Ballenger
Jim Busse

Sera Drevenak
David Grubbs
Jimmy Hull
Kevin Kolmos
Josh Loefer
David Nelson
Paul Nelson
Ron Surreny
Gregg Swanson
Robert Welch
Byron White

**Acronyms**
**SEDAR 24 Participants List**
**South Atlantic Red Snapper**

| | |
|---|---|
| ACCSP | Atlantic Coastal Cooperative Statistics Program |
| AFSC | Alaska Fisheries Science Center |
| CIE | Center for Independent Experts |
| FL FWCC | Florida Fish and Wildlife Conservation Commission |
| GA DNR | Georgia Department of Natural Resources |
| MARMAP | Marine Resources Monitoring, Assessment, and Prediction |
| MRIP | Marine Recreational Information Program |
| NC DMF | North Carolina Division of Marine Fisheries |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| RS | Red Snapper |
| SEFSC | Southeast Fisheries Science Center, National Marine Fisheries Service |
| SERO | Southeast Regional Office, National Marine Fisheries Service |
| SC DNR | South Carolina Department of Natural Resources |
| SEDAR | Southeast Data, Assessment, and Review |
| SG AP | Snapper Grouper Advisory Panel |
| SSC | Science and Statistics Committee |
| TBN | To be named |
| TIP | Trip Interview Program, National Marine Fisheries Service |

## 1.4 List of Working Papers and Reference Documents

SEDAR24
South Atlantic Red Snapper
Workshop Document List

| Document # | Title | Authors |
|---|---|---|
| **Documents Prepared for the Data Workshop** | | |
| SEDAR24-DW01 | Discards of Red Snapper Calculated for Vessels with Federal Fishing Permits in the US South Atlantic | K. McCarthy 2010 |
| SEDAR24-DW02 | SEDAR 24 South Atlantic Red Snapper Management Summary | J. McGovern 2010 |
| SEDAR24-DW03 | Standardized catch rates of U.S. Atlantic red snapper (*Lutjanus campechanus*) from headboat data | Sustainable Fisheries Division, NMFS 2010 |
| SEDAR24-DW04 | Standardized catch rates of U.S. Atlantic red snapper (*Lutjanus campechanus*) from commercial logbook data | Sustainable Fisheries Division, NMFS 2010 |
| SEDAR24-DW05 | Red snapper standardized catch rates from the Marine Recreational Fisheries Statistics Survey for the U.S. Atlantic Ocean, 1981-2009 | Indices Group MRFSS 2010 |
| SEDAR24-DW06 | Distribution of red snapper catches from headboats operating in the South Atlantic | Sustainable Fisheries Division, NMFS 2010 |
| SEDAR24-DW07 | Georgia Headboat Red Snapper Catch & Effort Data, 1983-2009 | S. Amick, K. Knowlton 2010 |
| SEDAR24-DW08 | Sampling Procedures Used in the Trip Interview Program (TIP) | Sustainable Fisheries Division, NMFS 2010 |
| SEDAR24-DW09 | Pre-Data Workshop Development of Commercial Landings for the Red Snapper Fishery | D. Vaughan, D. Gloeckner 2010 |
| SEDAR24-DW10 | Age Workshop for Red Snapper | J. Potts, editor 2009 |
| SEDAR24-DW11 | Review and Analysis of Methods to Estimate Historic Recreational Red Snapper Landings in the South Atlantic | SEDAR24 Historic Rec Catch Group 2010 |
| SEDAR24-DW12 | Red Snapper Discard Mortality Working Paper | SEDAR24 Discard Mortality Group |

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| | | 2010 |
| SEDAR24-DW13 | South Atlantic Red Snapper Marine Recreational Fishery Landings: FHS-conversion of Historic MRFSS Charter Boat Catches | T. Sminkey 2010 |
| SEDAR24-DW14 | Marine Resources Monitoring, Assessment and Prediction Program: Report on Atlantic Red Snapper, *Lutjanus campechanus,* for the SEDAR 24 Data Workshop | MARMAP 2010 |
| SEDAR24-DW15 | Red Snapper Length Frequencies and Condition of Released Fish from At-Sea Headboat Observer Surveys, 2004 to 2009. | B. Sauls and C. Wilson 2010 |
| **Documents Prepared for the Assessment Workshop** | | |
| SEDAR24-AW01 | Assessment History of Red Snapper (*Lutjanus campechanus*) in the U.S. Atlantic | Sustainable Fisheries Branch, NMFS 2010 |
| **Documents Prepared for the Review Workshop** | | |
| SEDAR24-RW01 | | |
| **Final Assessment Reports** | | |
| SEDAR24-SAR | Assessment of Red Snapper in the US South Atlantic | To be prepared by SEDAR 24 |
| **Reference Documents** | | |
| SEDAR24-RD01 | Age, Growth, And Reproduction Of The Red Snapper, *Lutjanus Campechanus,* From The Atlantic Waters Of The Southeastern U.S. | D. B. White, S. M. Palmer 2004 |
| SEDAR24-RD02 | Age and growth of red snapper, *Lutjanus Campechanus*, from the southeastern United States | S. McInerny 2007 |
| SEDAR24-RD03 | Commercial catch composition with discard and immediate release mortality proportions off the southeastern coast of the United States | J. A. Stephen, P. J. Harris 2010 |
| SEDAR24-RD04 | The 1960 Salt-Water Angling Survey, USFWS Circular 153 | J. R. Clark c.1962 |
| SEDAR24-RD05 | The 1965 Salt-Water Angling Survey, USFWS Resource Publication 67 | D. G. Deuel, J. R. Clark 1968 |
| SEDAR24-RD06 | 1970 Salt-Water Angling Survey, NMFS Current Fisheries Statistics Number 6200 | D. G. Deuel 1973 |
| SEDAR24-RD07 | Lecture Notes on Coastal and Estuarine Studies, #10 Fisheries Management, Ch VII Marine Sport Fisheries | J. L. McHugh 1984 |
| SEDAR24-RD08 | Survey of Offshore Fishing in Florida | M. A. Moe, Jr. 1963 |

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| SEDAR24-RD09 | Geographic Comparison of Age, Growth, Reproduction, Movement, and Survival of Red Snapper off the State of Florida | K. M. Burns, N. J. Brown-Petterson, R. M. Overstreet 2006 |
| SEDAR24-RD10 | Regional Differences in Florida Red Snapper Reproduction | N. J. Brown-Petterson, K. M. Burns, R. M. Overstreet 2008 |
| SEDAR24-RD11 | Evaluation of the Efficacy of the Minimum Size Rule in the Red Grouper and Red Snapper Fisheries With Respect to J and Circle Hook Mortality and Barotrauma and the Consequences for Survival and Movement | K. M. Burns 2009 |
| SEDAR24-RD12 | Survival of Released Red Snapper progress Report | R. O. Parker, Jr. 1985 |
| SEDAR24-RD13 | Survival of Released Reef Fish—A Summary of Available Data (Preliminary) | R. O. Parker, Jr. 1991 |
| SEDAR24-RD14 | Incorporating Mortality from Catch and Release into Yield-per-Recruit Analyses of Minimum-Size Limits | J. R. Waters, G. R. Huntsman 1986 |
| SEDAR24-RD15 | Modified hooks reduce incidental mortality of snapper (*Pagrus auratus*: Sparidae) in the New Zealand commercial longline fishery | T. J. Willis, R. B. Millar 2001 |
| SEDAR24-RD16 | Key principles for understanding fish bycatch discard mortality | M. W. Davis 2002 |
| SEDAR24-RD17 | Indirect Estimation of Red Snapper (Lutjanus campechanus) and gray Triggerfish (*Balistes capriscus*) Release Mortality | W. F. Patterson, III, G. W. Ingram, Jr., R. L. Shipp, J. H. Cowan, Jr. 2002 |
| SEDAR24-RD18 | Red Snapper Discards in Texas Coastal waters-a Fishery Dependent Onboard Survey of Recreational Headboat Discards and Landings | B. A. Dorf 2003 |
| SEDAR24-RD19 | Partitioning Release Mortality in the Undersized Red snapper Bycatch: Comparison of Depth vs. Hooking Effects | K. M. Burns, N. F. Parnell, R. R. Wilson, Jr. 2004 |
| SEDAR24-RD20 | Catch-and-release science and its application to conservation and management of recreational fisheries | S. J. Cooke, H. L. Schramm 2007 |
| SEDAR24-RD21 | Discard composition and release fate in the snapper and grouper commercial hook-and-line fishery in North Carolina, USA | P. J. Rudershausen, J. A. Buckel, E. H. Williams 2007 |

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| SEDAR24-RD22 | Evaluating the physiological and physical consequences of capture on post-release survivorship in large pelagic fishes | G. B. Skomal 2007 |
| SEDAR24-RD23 | Release Mortality of Undersized Fish from the Snapper–Grouper Complex off the North Carolina Coast | A. S. Overton, J. Zabawski, K. L. Riley 2008 |
| SEDAR24-RD24 | Capture depth related mortality of discarded snapper (*Pagrus auratus*) and implications for management | J. Stewart 2008 |
| SEDAR24-RD25 | Linking ''Sink or Swim'' Indicators to Delayed Mortality in Red Snapper by Using a Condition Index | S. L. Diamond, M. D. Campbell 2009 |
| SEDAR24-RD26 | Does Venting Promote Survival of Released Fish? | G. R. Wilde 2009 |
| SEDAR24-RD27 | Field Experiments on Survival Rates of Caged and Released Red Snapper | G. R. Gitschlag, M. L. Renaud 1994 |
| SEDAR24-RD28 | Red Snapper in the Northern Gulf of Mexico: Age and Size Composition of the Commercial Harvest and Mortality of Regulatory Discards | D. L. Nieland, A. J. Fischer, M. S. Baker, Jr., C. A. Wilson, III 2007 |
| SEDAR24-RD29 | Factors Affecting Catch and Release (CAR) Mortality in Fish: Insight into CAR Mortality in Red Snapper and the Influence of Catastrophic Decompression | J. L. Rummer 2007 |
| SEDAR24-RD30 | Evaluation of The Efficacy of the Current Minimum Size Regulation for Selected Reef Fish Based on Release Mortality and Fish Physiology | K. M. Burns, N. J. Brown-Peterson, R. M. Overstreet 2008 |
| SEDAR24-RD31 | American Fishes - A Popular Treatise upon the Game and Food Fishes of North America with Especial Reference to Habits and Methods of Capture | G. B. Goode, T. Gill 1903 |
| SEDAR24-RD32 | Proceedings: Colloquium on Snapper-Grouper Fishery Resources of the Western Central Atlantic Ocean | H. R. Bullis, Jr., A. C. Jones 1976 |
| SEDAR24-RD33 | Growth and Mortality of Red Snappers in the West-Central Atlantic Ocean and Northern Gulf of Mexico | R. S. Nelson, C. S. Manooch, III 1982 |
| SEDAR24-RD34 | Yield Per Recruit Models of Some Reef Fishes of the U. S. South Atlantic Bight | G. R. Huntsman, C. S. Manooch, III, C. B. Grimes 1983 |
| SEDAR24-RD35 | Population Assessment of the Red Snapper, *Lutjanus campechanus*, from the Southeastern United States | C. S. Manooch, III, J. C. Potts, D. S. Vaughan, M. L. |

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| | | Burton 1997 |
| SEDAR24-RD36 | Executive Summary: Review of Recreational Fisheries Survey Methods | National Research Council 2006 |
| SEDAR24-RD37 | Spawning Locations for Atlantic Reef Fishes off the Southeastern U.S. | G. R. Sedberry, O. Pashuk, D. M. Wyanski, J. A. Stephen, P. Weinbach 2006 |
| SEDAR24-RD38 | More Red Snapper Discussion | J. H. Cowan, Jr. 2009 |
| SEDAR24-RD39 | A Perspective of the Importance of Artificial Habitat on the Management of Red Snapper in the Gulf of Mexico | R. L. Shipp, S. A. Bartone 2009 |
| SEDAR24-RD40 | National Survey of Fishing and Hunting | Dept Interior 1955 |
| SEDAR24-RD41 | National Survey of Fishing and Hunting 1960 | Dept Interior 1960 |
| SEDAR24-RD42 | FMP, Regulatory Impact Review, and Final Environmental Impact Statement for the SG Fishery of the South Atlantic Region | SAFMC 1983 |
| SEDAR24-RD43 | Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes<br>and Invertebrates (Gulf of Mexico) – Red Snapper | D. Morgan 1988 |
| SEDAR24-RD44 | Evaluation of Multiple Factors Involved in Release Mortality of Undersized Red Grouper, Gag, Red Snapper and Vermilion Snapper | K. M. Burns, C. C. Koenig, F. C. Coleman 2002 |
| SEDAR24-RD45 | Physiological Effects of Swim Bladder Overexpansion and Catastrophic Decompression on Red Snapper | J. L. Rummer, W. A. Bennet 2005 |
| SEDAR24-RD46 | A Review of Movement in Gulf of Mexico Red Snapper: Implications for Population Structure | W. F. Patterson, III 2007 |
| SEDAR24-RD47 | J and Circle Hook Mortality and Barotrauma and the Consequences for Red Snapper Survival | K. M. Burns 2009 |
| SEDAR24-RD48 | Procedural Guidance Document 2 - Addressing Time-Varying Catchability | SEDAR 2009 |
| SEDAR24-RD49 | Final Report on Bioeconomic Analysis of the Red Snapper Rebuilding Plan and Transferable Rights Policies in the Gulf of Mexico <u>with</u> Supplementary Technical Document to the Final Report | W. L. Griffin, R. T. Woodward 2009 |
| SEDAR24-RD50 | Comments On SPR-Based Benchmarks For Red Snapper Stocks in the Southeastern USA | R. Methot, P. Rago, G. Scott |

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| | | 2009 |
| SEDAR24-RD51 | The Recreational fishery in South Carolina: The Little River Story | V. G. Burrell 2000 |
| SEDAR24-RD52 | Southeastern U.S. Deepwater Reef Fish Assemblages, Habitat characteristics, Catches, and Life History Summaries | R. O. Parker, R. W. Mays 1998 |
| SEDAR24-RD53 | American Game and Food Fishes pp 410-412 | D. S. Jordan, B. W. Evermann 1908 |
| SEDAR24-RD54 | Comparison of two approaches for estimating natural mortality based on longevity. | D. A. Hewitt, J. M. Hoenig 2005. |
| SEDAR24-RD55 | Notes on the red snapper fishery | J. W. Collins 1886 |
| SEDAR24-RD56 | Southeast Region Headboat Survey Program Description | K. Brennan 2010 |
| SEDAR24-RD57 | Biological-Statistical Census of the Species Entering Fisheries in the Cape Canaveral Area | W. W. Anderson, J. W. Gehringer 1965 |
| SEDAR24-RD58 | Abundance Indices Workshop: Developing protocols for submission of abundance indices to the SEDAR process. SEDAR Procedures Workshop 1 | SEDAR 2008 |
| SEDAR24-RD59 | Source Document for the Snapper-Grouper Fishery of the South Atlantic Region | SAFMC 1983 |
| SEDAR24-RD60 | Projected Combined Effects of Amendments 13C, 16, and 17A Regulations on south Atlantic<br>Red Snapper Removals.<br>SERO-LAPP-2009-07(Rev) | SERO v Jan 2010 |
| SEDAR24-RD61 | Catch Characterization and Discards within the Snapper Grouper Vertical Hook-and-Line Fishery of the South Atlantic United States | Gulf & SA Fisheries Foundation 2008 |
| SEDAR24-RD62 | Returns from the 1965 Schlitz Tagging Program Including a Cumulative Analysis of Previous Results | D. S. Beaumariage 1969 |
| SEDAR24-RD63 | Length of Recall Period and Accuracy of Estimates from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation | W. L. Fisher, A.E. Grambsch, D.L. Eisenhower, D.R. Morganstein 1991 |
| **Previous SEDARs Documents of Interest** | | |
| SEDAR7-DW13 | The steepness stock-recruit parameter for red snapper in the Gulf of Mexico (Lutjanus campechanus): what can be learned from other fish stocks? | M. K. McAllister 2004 |
| SEDAR7-DW19 | Estimating Catches and fishing Effort of the Southeast United States Headboat Fleet, 1972-1982 | R. L. Dixon, G. R. Huntsman, Undated Draft |

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| SEDAR7-AW16 | Estimates of Historical Red Snapper Recreational Catch Levels Using US Census Data and Recreational Survey Information | G. P. Scott 2004 |
| SEDAR7-SAR1 | Stock Assessment Report Gulf of Mexico Red Snapper, SEDAR7 Assessment Report 1 | SEDAR 2005 |
| SEDAR17-RD18 | The summer flounder chronicles: Science, politics, and litigation, 1975-2000. | M. Teceiro 2002 |
| SEDAR17-RD20 | Comparing 1994 angler catch and harvest rates from on-site and mail surveys on selected lakes. | B. Roach, J. Trial, and K. Boyle 1999. |
| SEDAR17-RD23 | Effects of recall bias and nonresponse bias on self-report estimates of angling participation. | M. A. Tarrant, M. J. Manfredo, P. B. Bayley, R. Hess 1993 |
| SEDAR19-DW05 | Evaluation of the 1960, 1965, and 1970 U.S. Fish and Wildlife Service salt-water angling survey data for use in the stock assessment of red grouper (Southeast US Atlantic) and black grouper (Southeast US Atlantic and Gulf of Mexico) | R. Cheshire, J. O'Hop 2009 |
| SEDAR7-DW51 | MSY, Bycatch and Minimization to the "Extent Practicable" | J. E. Powers 2004 |
| SEDAR19-RD27 | The Natural Mortality Rate of Gag Grouper: A Review of Estimators for Data-Limited Fisheries. | T. J. Kenchington |

## 1.5 Itemized List of Tasks for Completion following Workshop

**SEDAR 24 Data Workshop**

**Post-Workshop Tasks List**

| Workgroup | Task | Principal | Due |
|---|---|---|---|
| Indices | Attempt to compute the standardized headboat at sea observer discards index | A. Schueller | June 18 |
| Indices | Draft of Indices section text to work group | A. Schueller | June 2 |
| Indices | Comments on text to work group leader | Indices panelists | June 9 |
| Indices | Final Indices section text to SEDAR | A. Schueller | June 11 |
| Commercial | Take S24DW09 and remove title page, begin rewrite by redrafting Decisions based on rapporteur notes (S. McInerny) and Leader notes (D. Vaughan) | D. Vaughan | June 4 |
| Commercial | Update landings tables and figures based on work at DW | D. Vaughan | June 4 |
| Commercial | Include material on discard estimates, including brief comments on S24DW01 report | K. McCarthy | June 4 |
| Commercial | Include write up concerning discard mortality calculations done during the DW and length comp for discards from observer data | D. Vaughan | June 4 |
| Commercial | Finalize landings in numbers at age and length compositions | D. Gloeckner | June 4 |
| Commercial | Finalize age compositions | D. Vaughan/ D. Gloeckner | June 4 |
| Commercial | Describe various selectivity discussions, including contribution from K. Fex | D. Vaughan | June 4 |
| Commercial | Include research recommendations in draft section | D. Vaughan | June 4 |
| Commercial | Look into GIS mapping for logbook landings/trips by latitude/longitude; and depth contour map (showing bottom features and/or currents?), at NMFS Beaufort Lab, if needed check with NC DMF | D. Vaughan<br>S. McInerny | June 9 |
| Commercial | Send out a completed draft of the Commercial section of the DW report | D. Vaughan | June 4 |

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|---|---|---|---|
| Commercial | Submit comments on draft Commercial section | Commercial panelists | June 9 |
| Commercial | Commercial input data (landings in numbers and weight & CVs, discard estimates and SE, length and age comps) will be provided to R. Cheshire for excel data (workbook) | D. Vaughan | June 7 |
| Recreational | Writing assignments due to K. Brennan | Recreational panelists | June 4 |
| Recreational | Send a rough draft of the Recreational section to the Recreational group for review | K. Brennan | June 4 |
| Recreational | Data to R. Cheshire for data workbook | K. Brennan | June 4 |
| Recreational | Recreational Group report section final review due | Recreational panelists | June 10 |
| Recreational | Writing assignments: At-Sea Observer Program Length Comps, FL At-Sea Observer Program, Historical data review, working paper review | B. Sauls | June 4 |
| Recreational | Writing assignments: At-Sea Observer Program Length Comps | C. Wilson | June 4 |
| Recreational | Writing assignments: working paper review | K. Knowlton | June 4 |
| Recreational | Writing assignments: working paper review, MRFSS data summaries | T. Sminkey | June 4 |
| Recreational | Writing assignments: Historic landings\ratio method, Discard Mortality | E. Williams | June 4 |
| Recreational | Writing assignments: Headboat Program Length\Age Comps, working paper review | R. Cheshire | June 4 |
| Recreational | Draft Recreational report section due to SEDAR | K. Brennan | June 11 |
| Life History | Submit a critique of SEDAR 24-DW #12 | J. Ballenger | June 1 |
| Life History | Submit a critique of SEDAR 24-DW#14 | J. Potts | June 1 |
| Life History | Send a rough draft of the Life History section to the Life History group for review | J. Potts | June 4 |
| Life History | Data to R. Cheshire for data workbook | J. Potts | June 4 |
| Life History | Life History Group report section final review due | Life History panelists | June 10 |
| Life History | Final Life History report section to SEDAR | J. Potts | June 11 |

# 2 Life History

## 2.1 Overview (Group Membership, Leader, Issues)

State and federal biologist and industry representatives comprised the Life History Work Group (LHWG)

Jennifer Potts – NMFS, Beaufort, NC, Leader of LHWG
Joseph Ballenger – SCDNR, Charleston, SC
Daniel Carr – NMFS, Beaufort, NC, Rapporteur
Chip Collier – NCDMF, Wilmington, NC
David Crisp – Industry Representative, Florida
Laurie DiJoy – SCDNR, Charleston, SC
Josh Loefer – SCDNR, Charleston, SC
Robert Johnson – Industry Representative, Florida
Janet Tunnell – FL FWC, St. Petersburg, FL
Byron White – SCNDNR, Charleston, SC
David Wyanski – SCDNR, Charleston, SC

The LHWG was tasked with combining age data from SEDAR15 with new age data sets from four sources: National Marine Fisheries Service Beaufort Laboratory (NMFS), South Carolina Department of Natural Resources (SCDNR), Georgia Department of Natural Resources (GADNR), and Florida Fish and Wildlife Conservation Commission (FL FWC). In order to combine age data from all sources, the LHWG needed to be sure that aging methodology between agencies was consistent. The four laboratories involved in aging US South Atlantic red snapper participated in an age workshop, followed by an exchange of otolith sections, to determine consistency in aging this species. A document was prepared (SEDAR24-DW10) and all four laboratories were consistently aging the fish. The data from the exchanges were provided to Dr. A. Schueller, NMFS, who created an age error matrix for use in the assessment model.

During the 2009 fishing year, dock side sampling for age structures was greatly increased. The LHWG was tasked with evaluating the expanded otolith sampling efforts conducted during 2009 and was to consider which samples were appropriate as indicators of fishery and population age structure (SEDAR24-DW-TOR #4).

The LHWG was also tasked with comparing and contrasting life history parameters between the US South Atlantic stock and the Gulf of Mexico stock (SEDAR24-DW-TOR #3). These comparisons will be addressed in the appropriate sections.

## 2.2 Review of Working Papers

### 2.2.1 Age workshop for red snapper (SEDAR24-DW-10)

*Abstract*

Age processing techniques and estimation can vary among labs leading to differences in demographic parameters used in stock assessment models. An age workshop was conducted to ensure that red snapper age sample preparation techniques and estimation are similar among labs that age red snapper in the US South Atlantic. Topics covered during the age workshop were methodology for preparing samples for aging, interpretation of the otolith macro-structure, and conversion of increment counts to ages. An initial APE of 11.3% between readers was calculated. Most of the potential differences were due to interpretation of the first annulus. Other issues with reading red snapper otoliths identified during the workshop were check mark or false annuli, determining otolith edge type, and aging only otoliths with sections taken from near the core. After the workshop, a second reference otolith set was sent to each aging lab and the overall average percent error improved to 6.15%. No bias was detected, and the data was symmetrically spread across the 1:1 diagonal. Because of these results, no ageing error correction is needed for the age data submitted for the SEDAR24 assessment.

*Critique*

SEDAR 24 DW Reference Document 10 was reviewed and deemed pertinent for the SEDAR process. This document described otolith preparation, annuli interpretation, edge type assignment, and age assignment.

### 2.2.2 Marine Resources Monitoring, Assessment and Prediction Program: Report on Atlantic red snapper, *Lutjanus campechanus*, for the SEDAR24 Data Workshop (SEDAR24-DW-14).

*Abstract*

During 2000 – 2009, MARMAP collected fishery-dependent and fishery-independent biological samples from red snapper inhabiting waters off North Carolina through the Florida Keys. The samples (n = 447) were used for age and growth and reproductive biology studies. These fish were caught using a variety of gears including trawls, traps, hook and line, spear, and longlines. MARMAP supplied two readers each for ageing and reproductive state. Ages ranged from 0 to 35 years (190 – 920 mm TL), but age 0 and 1 year old fish were very rare in the samples. These age data will be combined with other age data sets provided to SEDAR24. The reproductive data in this report is the most comprehensive information on Atlantic red snapper that exists. Overall sex ratio of Atlantic red snapper is 1:1 with age at 50% maturity for females at 1.87 years. For males, 50% were mature at age 1, though the low sample size of males in the younger ages may not give a true estimate of the male maturity schedule.

*Critique*

SEDAR24-DW-14 provides a good overview of the sampling efforts of MARMAP for age and reproductive biology data. The reproductive data are the most reliable data to use in SEDAR24, thus this report is pertinent to SEDAR24 Data Workshop.

## 2.3 Stock Definition and Description

No new evidence is available that suggests the Atlantic and Gulf should be managed as a single stock, and no new evidence of regional separation within the Atlantic is available. The Life History group recommends that the Atlantic be recognized as a single stock. The Gulf of Mexico is currently divided into eastern and western gulf components, but the sub-stocks are managed as a single unit (SEDAR7).

### 2.3.1 Population genetics

Evidence does not exist for separate Gulf of Mexico and Atlantic populations. Garber et al. (2004) described the population ranging from the Gulf of Mexico to the Atlantic coast of Florida as a “single, panmictic population”. A study by Saillant et al. (2010) based on nuclear-encoded microsatellites found that “spatial genetic structuring among young-of-the-year red snapper in the Gulf occurs at small geographic scales and is consistent with a metapopulation stock-structure model of partially connected populations.” Investigation of Atlantic Coast population genetics is under way (J.R. Gold, Texas A&M, personal communication, April 2010).

### 2.3.2 Demographic patterns

The LHWG investigated the potential for spatial differences in maturity, growth, and length at age. There was evidence that fish in the Florida-Georgia (South) region may mature younger and smaller than in the Carolinas (North) region (See section 2.8) There was no difference in mean length-at-age or growth between the two regions (Figure 2.7.1).

### 2.3.3 Otolith microchemistry

In order to further clarify the issue of separate stocks within the SA, the LHWG recommend that further research should be focused on otolith micro-chemistry. The use of otolith microchemistry may make it possible to distinguish Gulf of Mexico and Atlantic coast fish, as well as investigate regional recruitment in the Atlantic.

### 2.3.4 Tagging

Tagging studies do not provide any new evidence that suggests movement between Gulf of Mexico and Atlantic stocks, other than one fish tagged off Pensacola, FL, and recaptured off St. Augustine, FL (Burns et al. 2008). Fishermen have suggested that seasonal migration of fish occurs among regions of the South Atlantic. Telemetry studies are recommended to investigate movement of fish along the Atlantic coast.

## 2.4 Natural Mortality

### 2.4.1 Juvenile (YOY)

Juvenile red snapper are rarely encountered (n = 0 to 4 per year) in a nearshore (<30 ft) fishery-independent trawling program (SEAMAP) in the Atlantic. Fishermen reported observing juvenile red snapper on artificial reefs in shallow water. Estimates of juvenile red snapper mortality have been developed in the Gulf of Mexico; however, little information is available for the US South Atlantic. Data on age 0 fish will not be included as inputs into the stock assessment model.

### 2.4.2 Adult

Natural mortality of red snapper was estimated using several methods. Initially, natural mortality (M) of red snapper was estimated to be 0.08 using both a regression model for a variety of taxa and a regression model for teleosts reported by Hoenig (1983):

$\ln(M) = 1.44-0.982*\ln(t_{max})$ Variety of Taxa (M=0.08397 rounded to 0.08)

$\ln(M) = 1.46-1.01*\ln(tmax)$ Teleosts (M=0.07662 rounded to 0.08)

Maximum observed age ($t_{max}$) was 54 years old. The maximum calendar age of red snapper in the Gulf of Mexico was reported as 57 yr (Allman et al. 2002), which differs slightly from the maximum age of 54 yr in the Atlantic (SEDAR15-RD06). Natural mortality was also estimated using a variety of models based on von Bertalanffy growth or reproductive parameters (Table 2.4.2.1). Using these alternative models (Alverson and Carney 1975, Beverton 1992, Pauly 1980, and Ralston 1987), M ranged from 0.01 – 1.27 along the Atlantic coast. The Lorenzen (1996) model provides an age-specific estimate of natural mortality that ranged from 0.90 – 0.21 for fish aged 2 to 54. These estimates of natural mortality for the oldest age classes (0.21) correspond to a fish with a maximum age of 19. Therefore the Lorenzen (1996) estimate was scaled to 1.4% surviving to maximum age based on Hoenig (1983) natural mortality estimate of 0.08. This resulted in a scaled estimate of natural mortality at age ranging from 0.30 to 0.07 (Table 2.4.2.2). Manooch et al. (1998) reported an estimate of M = 0.25, but the maximum age in their study was 25 yr. An atypically low natural mortality estimate (M = 0.005) for Atlantic red snapper was derived from the Alverson and Carney (1975) equation. High estimates of natural mortality (>0.3) were derived from Pauly (1980), Ralston (1987), and Beverton (1992) with values of 0.41, 0.57, and 1.27, respectively. The uncommonly high estimate (M = 1.27) from the equation by Beverton (1992) may be due to the unique life history of red snapper. Red snapper mature at an early age ($A_{50}\%$ =1.87 years) but have the potential to live >50 yr. With respect to age at maturity relative to maximum age, red snapper do not follow the regression relationship previously established for some long-lived fishes (Beverton 1992). Regression analysis of the fully recruited ages, 4-54 years, in the population based on the aged samples estimated total mortality to be 0.44, which is close to the Pauly estimate and below the Ralston estimates of natural mortality.

*Issues*

1. What value of maximum age of red snapper should be used?

2. Natural mortality estimates using models based on growth and reproductive parameters were highly variable.

*Recommendations*

1. The DW recommended using the observed maximum age of 54 years. Although there were few fish over the age of 20, two fish were harvested from the South Atlantic over 50 years old and the maximum age observed in the Gulf of Mexico was 57.

2. The DW recommended using the scaled age-specific Lorenzen natural mortality estimate for age 1+ since this is a commonly used method to estimate natural mortality. There was some discussion on the differences between the Atlantic and Gulf of Mexico SEDARs approximation of natural mortality. The update of the SEDAR 7 assessment is using a natural mortality of 1.2 for age 1 fish and 0.1 for ages 2+. However the DW felt the scaled Lorenzen model was most appropriate. This model is able to account for changing natural mortality rates with age and can be scaled to a point natural mortality estimate based on both of Hoenig's (1983) equations: teleosts and all taxa. It was recommended to use a natural mortality rate of 0.6 for age 1 fish as a sensitivity run. The DW recommended sensitivity runs using a range of M, 0.05-0.12, about the Hoenig point estimate. These sensitivity runs will encompass the estimates of M used in the Gulf red snapper update assessment (2009).

## 2.5 Discard Mortality

Red Snapper Discard Mortality Working Paper (SEDAR24-DW-12)

*Abstract*

SEDAR 24-DW-12 provides a thorough overview of what we know regarding the discard mortality rates for red snapper in the South Atlantic region. It provides background information on what factors can affect discard mortality rates as well as the discard mortality rates that were used in previous SEDAR stock assessments of red snapper. Subsequently, it summarizes the discard mortality rates calculated for red snapper in various studies, with the caveat that researchers conducted most of these studies in the Gulf of Mexico. Because the Gulf of Mexico red snapper fisheries act much differently than the South Atlantic red snapper fisheries, the validity of applying data from these studies to the South Atlantic is potentially in question. Thus, a great deal of emphasis is placed on understanding the causes of discard mortality (primary causes: hooking related injuries and barotraumas; secondary causes: temperature, predation, and size), so that data from the Gulf region can be used to estimate the discard mortality rates in the South Atlantic. Concerning hooking related injuries, this appears to be the major factor causing discard mortality in headboat fisheries, as researchers attributed almost 50% of mortalities to hooking injuries. For barotraumas, it appears that red snapper are slightly less susceptible to death from the injuries, due to the structure of their swim bladder compared to many other fish species, but that size (smaller = greater survival, larger = lower survival) can have an effect as well. In addition, most studies indicated that depth of capture was a significant factor in determining whether barotrauma injuries would

result in mortality, with chance of death increasing with increasing depth. Thus, to account for this increasing discard mortality rate with depth of capture, researchers had investigated three separate models to predict mortality rate at depth of capture. Finally, the working paper discusses several additional secondary factors (e.g. air exposure, hook type, temperature, predation) affecting the discard mortality rate. It appears that we need to obtain and analyze more data to provide estimates of the discard mortality rates associated with each of these secondary factors.

*Critique*

Overall, this is a vital document that we should consider when determining appropriate discard mortality rates for red snapper in the South Atlantic region. The working paper coalesces several different sources of information in a summary working paper. Though the data on some factors potentially affecting the discard mortality rates of South Atlantic red snapper is sparse to non-existent, the model fits provided seem to reasonably fit the data and be in general agreement over the depth ranges that red snapper are often captured in the South Atlantic region. More work should be put forward trying to obtain estimates of the effect that the various secondary factors identified have on overall discard mortality rates. These estimates will allow more precise estimates of discard mortality rates in the South Atlantic region. In addition, it remains unclear from the working document how one should include hooking related mortality in the overall discard mortality rates, as the models presented only accounted for mortality related to barotraumas.

## 2.6 Age

The NMFS, the SCDNR, the GADNR and the FL FWC contributed both fishery dependent and fishery independent age data for this assessment. The final age data set included all age data from SEDAR15, which included age data from 1977 – 2006, and the new age data collected from 2006-2009. Most of the age samples were randomly collected by port agents intercepting fishing trips: commercial n = 5,671; charter boat n = 2,012; private boat n = 85; headboat n = 5,716. (See Tables 2.6.1 and 2.6.2 for randomly collected commercial and recreational fishery age samples and number of trips intercepted.) An additional 586 samples came from fishery-independent studies. All 2006 – 2009 age data included an increment count, an adjusted calendar age based on timing of annulus formation and an estimate of the amount of translucent edge present, and the determined fractional age using a July 1 birth date. The SEDAR15 age data were updated to include calendar age and fractional age.

Sampling intensity for age structures greatly increased during the 2009 fishing year and during the summer months in particular. Concern was raised about any potential length bias in the random sampling during that time. A comparison of the length composition of the age samples from 2009 versus the 2007 and 2008 fishing years was done for the commercial sector and the recreational sector separately. Length frequencies from 2009 mirrored those from 2007 and 2008 in both sectors and thus all of the age data from 2009 was usable for the assessment model.

*Issues*

GADNR conducted a complete census of red snapper landed during May 2009 by three recreational vessels. Concern was raised that the high number of samples ($n_{May}$ = 284) from one month in the year may bias the overall age structure of the red snapper landings for the entire year ($n_{year}$ = 679). This issue was particularly noted by industry representatives who have commented that red snapper seem to move through the fishing grounds either latitudinally or longitudinally.

A few of the 2009 samples (n = 68) from the commercial and headboat fisheries were selected by fishermen for the largest fish in the catch.

*Recommendations*

1. GADNR May census data were plotted against the GADNR random samples for the entire year. No discernable difference was noted in the age frequency or the length distribution between the two sets of data. LHWG recommended keeping the May census data in the dataset used for age composition of the recreational fishery.

2. The fishermen selected samples were identified and will not be used in the age composition data to characterize the fishery, but will be used in the growth model and analysis of fishing by depth of water.

### 2.6.1 Age Reader Precision and Aging Error Matrix

The data for the aging error analysis comes from otoliths which were read by four readers, who each represented a lab. The labs involved included the National Marine Fisheries Service (NMFS), Florida, Georgia, and the Marine Resources Monitoring, Assessment and Prediction program (MARMAP). As part of a workshop to improve precision between labs, a set of otoliths from the South Carolina Department of Natural Resources (n=95) reference collection was aged at the start of the workshop, and a set of otoliths from the Florida reference collection (n=100) was aged after the workshop. See data working paper SEDAR24-DW-10 for more information.

Based on the paired age reads from the workshop, some concern existed that previous to the workshop calibration, the MARMAP age estimates may have had a bias associated with them as compared to the estimates from the other labs. To explore whether or not a bias likely existed, the average age estimated from NMFS, FL, and GA, was compared to the age estimated by MARMAP. The distribution of average ages when compared to the ages estimated by MARMAP were scattered about the 1:1 line, which indicates that a bias is likely not occurring (Figure 2.6.1.1). With the absence of bias, the aging error matrix can be estimated directly from the paired age estimates from the otoliths.

Data from NMFS, Florida, and MARMAP were used to estimate the aging error matrix. The paired age reads from Georgia were not included in the analysis because Georgia has a low number of age samples over a small location that will be contributed to the age compositions for the assessment. In addition, the samples from Georgia were excluded mainly because of similarity to Florida, because the age reader in Florida trained the reader in Georgia. This would minimize any potential differences that would arise between the labs that age otoliths and would reduce the error to levels likely lower than what the overall data exhibit.

Accounting for error in age estimation is important for age composition data used in stock assessments (Punt et al. 2008). Thus, to account for any error associated with the age estimation process for south Atlantic red snapper and to get contemporary precision estimates, an aging error analysis was completed using a program called “agemat” provided by André Punt. Agemat can use age estimation data from multiple readers in order to estimate the coefficient of variation and standard deviation associated with age estimates and to provide an aging error matrix. This program has been used by other SEDAR assessments (ASFMC 2010).

Agemat requires some model specifications, such as the minimum and maximum age of the species, a reference age, and the type of standard deviation to be estimated, in addition to inputting the aging data and number of readers in the appropriate format. The minimum age used for this analysis was age 0, and the maximum age used for this analysis was 54. The reference age was age 4. The standard deviation was estimated using an asymptotic function. The maximum allowable standard deviation was input as 5; however, the model did not come near that bound.

The standard deviation was an increasing, asymptotic curve, which started at a low of 0.43 at age 0 and increased to maximum of 0.82 for fish age 54 (Figure 2.6.1.2). The coefficient of variation was a decreasing, asymptotic curve, which started at a high of 0.43 at age 0 and decreased to a minimum of 0.02 at age 54 (Figure 2.6.1.2). The aging error matrix is provided in Table 2.6.1.1.

Research recommendation: Continuing the age reading comparisons and calibrations between labs on a reference collection of known age fish would be beneficial for determining a more accurate aging error matrix and would provide accuracy to the age composition data.

### 2.6.2 Year Class Strength

Several strong year classes were evident for Atlantic red snapper between 1977 and 2009. These strong year classes were present in 1983, 1984, 1986 – 1989, 1991 – 1993, 1996, 1999 – 2001, and 2005 (Figure 2.6.2.1). These cohorts could be followed through the fishery for as long as 5 – 8 yr, first appearing most commonly as age 2 and 3 fish. Moderate to strong year classes appeared to occur on average every 2 yr. Prior to 1983, large pulses of 2 and 3 year old red snapper were entering the fishery indicating possible strong year classes, but these cohorts could not be followed after age 3 (SEDAR15-RD06; SEDAR24 new data).

## 2.7 Growth

Researchers have published several age and growth studies on red snapper in the U.S. South Atlantic (Nelson and Manooch 1982; Manooch and Potts 1997; SEDAR15-RD04; McInerny 2007). The updated age data sets used for the assessment includes 6,107 newly processed samples along with samples from three out of the four previous aging studies (Manooch and Potts 1997; McInerny 2007, SEDAR15-RD04), thus allowing a more complete analysis of red snapper age and growth along the Atlantic coast with increased spatial and temporal coverage. To develop an overall growth model for Atlantic red snapper, we combined all data available from the previously mentioned sources, resulting in a sample size of 13,431 fish.

As dimorphic growth is often apparent between sexes, we initially investigated the potential of dimorphic growth between male and female Atlantic red snapper. Using the age data for which sex was determined, we compared male and female von Bertalanffy growth models using Kimura's (1980) likelihood ratio test, Akaike's (1974) information criterion (AIC), and the Bayesian information criterion (BIC; Schwarz 1978). Resulting statistics (Table 2.7.1) suggested that there was no dimorphic growth between the sexes, thus we pooled the data to develop a sexes combined growth model.

In addition, it was thought that Atlantic red snapper growth may be region specific, with two regions being defined, one along the South Carolina and North Carolina coast (North region) and the other along the Georgia and Florida coast (South region). The age samples are assigned to states based on where fish were landed as opposed to actual fishing locations, which may differ considerably. With that caveat, Atlantic red snapper growth between the two regions was investigated and compared using the same techniques used to investigate the potential for dimorphic growth between the sexes. Though resulting statistics (Table 2.7.2) suggested that dimorphic growth occurred among the regions, plots of region specific growth curves (Figure 2.7.1) suggested little biological difference in the growth models.

We also investigated the potential for differences in growth among the types of data available (commercial (n = 5,480), recreational (n = 7,365), and fishery-independent (n = 586)). Plots of the growth models by fishery type (Figure 2.7.2) suggested no difference in the growth models developed for the commercial or recreational fisheries. While the fishery-independent data growth model varied slightly, this was probably due to the much smaller sample size available and the lack of older fish, which affects the estimate of the $L_\infty$ parameter of the fishery-independent model (Figure 2.7.3).

Finally, because growth models can be influenced by the use of size-biased samples, for example, due to minimum size limits affecting fishery-dependent sampling, an overall, unweighted von Bertalanffy growth model that corrects for size-selective data and assumes a constant standard deviation (SD) was constructed ($L_\infty$ = 902 (SE = 4.29 mm), k = 0.245 (SE = 0.0038), $t_0$ = -0.03 (SE = 0.0303), SD = 78.72 (SE = 0.615); Figure 2.7.4; Diaz et al. 2004). The model was fit using temporal specific size-limits (1983 to 1991, 12 inches total length (TL); 1992 to 2009, 20 inches TL), observed or fork length converted total lengths and fractional ages determined based on the month of peak spawning (July).

US South Atlantic red snapper appear to grow faster and attain a larger maximum size than the Gulf of Mexico (GOM) stock (figure 2.7.5). The GOM stock is predicted to be 80-90 mm shorter than the Atlantic stock for the first four years, 50mm shorter at age 10 and 30 mm shorter by age 20. The GOM model may have had more young-of-the-year fish that went into the model accounting for the different estimates of $t_0$ and the other parameters. When looking at the fit of von Bertalanffy model to the Atlantic data, the LHWG felt that the model was a good fit and recommended its use in the Atlantic assessment.

*Issues*

1. The potential for dimorphic growth between sexes for Atlantic red snapper resulting in sex-specific growth models.

2. The potential for regional differences in the growth of Atlantic red snapper, resulting in region specific growth models. Growth may vary among Atlantic red snapper along a North/South gradient.

3. The potential for differences in growth models among commercial, recreational, and fishery-independent samples.

4. Size limit regulations for Atlantic red snapper changed within the study time period of 1977 to 2009 resulting in size-selective fishery-dependent samples (SEDAR15-RD06). The von Bertalanffy growth model may be influenced by size-selective sampling and may not appropriately represent the growth of the population.

*Recommendations*

1. Based on the results of growth model comparisons between sexes (Table 2.7.1), the LHWG recommended that a sex pooled growth model be developed for Atlantic red snapper to be used in the assessment model.

2. Though model comparisons suggest there may be regional differences in growth of Atlantic red snapper, the LHWG recommended that a region pooled growth model be developed for Atlantic red snapper because of several concerns. First, there was no biological reason for separating the regions along the Georgia/South Carolina border. Second, inclusion of data in one region or the other was determined based on the state in which the fish were landed, not necessarily the location where the fish were caught. Thus, the state landed may not accurately represent the region where the individual fish was caught. Finally, few young fish (< 3 years old, Figure 5) were landed in the northern region, thus affecting the estimate of $t_0$ of the von Bertalanffy growth equation for the northern region, resulting in an estimated $t_0$ parameter of -1.9 years, which is not biologically realistic. The LHWG felt the statistical difference in region specific growth models were likely driven by the estimate of the $t_0$ parameter, and upon visual inspection of the growth model at older ages saw little indication of differences in growth pattern.

3. Based on the plots of fishery specific growth models for Atlantic red snapper, the LHWG recommended developing a fishery pooled growth curve for Atlantic red snapper. There was no difference between the growth of commercially and recreationally caught Atlantic red snapper, and the observed difference in predicted growth of fishery-

independent caught Atlantic red snapper was likely due to the smaller sample size and lack of older fish in the sample (Figure 2.7.6).

4. The LHWG recommended developing a modified von Bertalanffy growth model correcting for size limited data for all data combined to represent the growth of red snapper in the U.S. South Atlantic (Diaz et al. 2004). This type of model was previously used to estimate growth curves for Atlantic and Gulf of Mexico gag grouper (SEDAR 10) as well as Gulf of Mexico (SEDAR 7) and Atlantic red snapper (SEDAR 15). The von Bertalanffy growth parameters are $L_\infty = 902$ (SE = 4.29 mm), k = 0.245 (SE = 0.0038), $t_0$ = -0.03 (SE = 0.0303), SD = 78.72 (SE = 0.615).

## 2.8 Reproduction

The MARMAP study by White and Palmer (SEDAR24-RD01) provides the most extensive information on the reproductive biology of red snapper along the Atlantic coast of the southeastern U.S. Specimens were collected during 1979-2000 and the majority (64%) of the specimens for the study came from a fishery-dependent source, primarily commercial snapper reel catches. Additional fishery-dependent (Project T12; years 2000-2001) and fishery-independent data (MARMAP chevron trap; years 2001-2009) were added to the dataset prepared for the current stock assessment. All commercial fishermen involved in the collection of specimens since 1999 were permitted to land undersized specimens. All age-related results presented in this section were based on calendar age. Information below on spawning seasonality, sexual maturity, sex ratio, and spawning frequency is based on the most accurate technique (histology) utilized to assess reproductive condition in fishes. Red snapper do not change sex during their lifetime (gonochorism).

### 2.8.1 Spawning Seasonality

Based on the occurrence of hydrated oocytes and/or postovulatory follicles, spawning along the Atlantic coast of the southeastern U.S. occurs from May through October and peaks during July through September (SEDAR24-RD01, Brown-Peterson et al. 2009). Mean values of a female gonadosomatic index based on specimens collected primarily off the Carolinas peaked in June and July, whereas an index for females based on specimens collected off the east coast of Florida (St. Augustine to Melbourne) had peaks in July and September. Spawning females were captured in mid-shelf to shelf-break (23-72 m) from Cape Fear, NC, to Melbourne, FL (SEDAR24-RD01).

### 2.8.2 Sexual Maturity

Region wide maturity ogives for male maturity at TL are available in tabular format in SEDAR24-RD14 (see Table 2.8.2.1). The smallest mature male was 210 mm TL and the youngest was age 1; and the largest immature male was 418 mm TL, the oldest was age 5. All males were mature at 451-500 mm TL and age 6. The estimates of $A_{50}$ (0.32 yr) and $L_{50}$ (199 mm TL) for males were unrealistic owing to the low number of smaller and younger (Ages 0 and 1) specimens. The smallest mature female was 265 mm TL, and the youngest was age 2; the size at 50% maturity was 370 mm TL (95% CI = 354-381), and the largest immature female was 435 mm TL, the oldest was age 4. All females were mature by 451-500 mm TL and age 5. Age at 50% maturity ($A_{50}$) for females was 1.87 yr (logistic; 95% CI = 1.48-2.12). The logistic equation (1-1/(1+exp(a+b*age); a = -2.71, b = 1.453) and normal equation (Prob(a+b*age); a = -8.11, b = 0.021) were used to estimate $A_{50}$ and length at 50% maturity ($L_{50}$) for females.

*Recommendation*

The LHWG recommended the use of maturity ogives generated for specimens collected throughout the region in the assessment. Recommendation was accepted at the plenary session of the Data Workshop.

### 2.8.3 Sex ratio

Tables with sex ratio by length class (mm TL), year, and age class are available in SEDAR24-DW-14 (see Tables 2.8.3.1, 2.8.3.2,and 2.8.3.3). The male:female sex ratio for all adult red snapper in fishery-independent and fishery-dependent collections from 1977-2009 was **1:0.98**, which was not significantly different from a 1:1 ratio (Chi-square = 0.11, $0.75 > p > 0.50$, n = 1113). An analysis of the two best years (1999-2000) of data revealed the same result (**1:1.00**, n = 545).

*Recommendation*

The LHWG recommended the use of a sex ratio of 1:1 (male:female) in the assessment. Recommendation was accepted at the plenary session of the Data Workshop.

### 2.8.4 Spawning Frequency

Only limited information is available for red snapper along the Atlantic coast of the U.S. Brown-Peterson et al. (2009) report that spawning occurs every 2.2 days based on a sample of 66 specimens collected during June through November. Estimates from Gulf of Mexico revealed that spawning frequency increases until about Age 6; little information is available for older ages (see Woods 2003; SEDAR7-DW-35).

### 2.8.5 Batch Fecundity (BF)

Only limited information is available for red snapper along the Atlantic coast of the U.S; the relationship between batch fecundity and TL (BF = 9548*TL – 5,224,104; $r^2 = 0.67$) was estimated for 12 specimens, 560-937 mm (Brown-Peterson et al. 2009). The small sample size and the lack of specimens < 560 mm make this equation of minimal use for the SEDAR24 assessment. An estimate of fecundity at age is available from Gulf of Mexico, but they are not as predictive as an estimate of fecundity at length (see Woods 2003; SEDAR7-DW-35) because batch fecundity reaches an asymptote at an age of approximately 10-12 yr.

Given the lack of a usable fecundity estimate from the Atlantic region, three proxies to estimate fecundity were considered: 1) gonad weight vs. age, 2) gonad weight vs. whole fish weight, and 3) gonad weight vs. total length (Figure 2.8.5.1). The first proxy (gonad weight vs. age; Fig. 2.8.5.1A) is not adequate because of a large gap in the age data, and, secondly, the linear nature of the relationship is inconsistent with the non-linear relationship evident between gonad weight and fish size (whole weight or TL) as fish grow (Figs. 2.8.5.1B and C). The second proxy is probably a better option, given the need to relate gonad weight to spawning biomass. The gonad weight ($W_g$) - whole fish weight ($W_f$) relationship is expressed as a power function:

$$W_g = 3.1416x10^{-5}\ W_f^{\ 1.743};\ \ SE_a = 3.1836x10^{-5},\ \ SE_b = 0.1107.$$

The gonad weight ($W_g$) - total length ($L_t$) relationship, third proxy, is expressed as a power function:

$$W_g = 1.207x10^{-11}\ L_t^{\ 4.524};\ \ SE_a = 3.16x10^{-11},\ \ SE_b = 0.3923.$$

*Recommendation*

The LHWG recommended the use of the second proxy, gonad weight – fish weight, as an estimate of fecundity in the assessment. Recommendation was accepted at plenary session of Data Workshop.

## 2.9 Movements & Migrations

Research on red snapper movements/migrations in Atlantic waters is limited. A few tagging studies have indicated high site fidelity. Anecdotal information suggests that larger red snapper spend most of their time in deeper water (>200 ft) than the majority of red snapper. These large, presumably older red snapper may move to shallower water during the spawning season. In an attempt to elucidate these statements concerning offshore migration, the total length of the fish in the age data were plotted against reported depth of capture (Figure 2.9.1a), as well as age versus depth of capture (Figure 2.9.1b). All fishery-dependent and fishery-independent data were combined. If a range of depths were reported for a trip, the midpoint of the range was used. There was no discernable difference in the distribution of fish by size or age over different depths. The LHWG acknowledges that the depth data reported in the fishery statistics is generalized for a trip. Also, the geography of the US South Atlantic varies widely from North Carolina to the Florida Keys. The data suggest that all sizes and ages of red snapper are available to all fisheries, but at what rate of availability we cannot say.

In the largest tagging study, Burns et al. (2004) tagged and released 5,272 red snapper in the Gulf of Mexico (from Naples, FL, to the eastern border of Texas) and Atlantic (from Cape Canaveral, FL, to Georgia) over a 13 yr period. Approximately 40% of these fish were tagged in the Atlantic. Forty-four percent of the specimens were recaptured within 1.9 km of the tagging site. Less than 10 of the 410 recapture events showed movement >100 miles and movement between the Gulf of Mexico and the Atlantic coast is not mentioned in the report.

In a later study, Burns et al (2008) reported 529 Gulf and Atlantic red snapper recaptures. Approximately 28.7% were recaptured within 3km, 15.1% were recaptured within 10 km, and only 3.8% were recaptured more than 50 km of the original tag site. In general, recaptures indicated north/south movement on the Atlantic coast and east and southeast movement (from the Panhandle) in the Gulf of Mexico. A single red snapper tagged in the Florida panhandle (during a previous study) was recaptured on the Atlantic coast of Florida.

The results of two smaller studies also indicate minimal movement in Atlantic red snapper. The SC Marine Gamefish Tagging Program reports 1,597 red snapper tagged with 171 recaptures. Ninety-three percent were recaptured within 2 km of the tagging site. SCDNR (MARMAP) data indicates 45 red snapper tagged with two recaptures, one of which was recaptured in the same vicinity as tagged. The other recapture had no location data.

Numerous publications have reported on red snapper tagging and movements in the Gulf of Mexico (Fable 1980; Szedlmayer 1997; Watterson et al. 1998; Ingram and Patterson 2001; Patterson et al. 2001b; Patterson and Cowan 2003; Szedlmayer and Schropfer 2005; Schropfer and Szedlmayer 2006). Four studies from the Gulf of Mexico (Fable 1980; Szedlmayer 1997; Szedlmayer and Schropfer 2005; Schropfer and Szedlmayer 2006) found that red snapper have high site fidelity, moving less than 0.2 km to 1.6 km from the original location tagged. Four other publications (Watterson et al. 1998; Ingram and Patterson 2001; Patterson et al. 2001b; Patterson and Cowan 2003) found that red snapper have low site fidelity (24.8-46% site fidelity estimates) in the Gulf of Mexico. However, three of those publications (Watterson et al. 1998; Ingram and Patterson 2001; Patterson et al. 2001b) state that the low fidelity was due to hurricanes. Watterson et al. (1998) report that 80% of the recaptured red snapper that were not at liberty during Hurricane Opal were recaptured at their site of release. Red snapper that were at liberty during Hurricane Opal had a significantly higher likelihood ($P < 0.001$) of movement away from their site.

*Recommendation*

More research on red snapper movements/migrations in Atlantic waters is needed. Available data and the results of studies in the Gulf of Mexico indicate high site fidelity. Tropical storms may cause greater than normal movement.

## 2.10 Meristics & Conversion factors

Red snapper lengths and weights were collected from fish landed in the recreational and commercial fisheries as well as fishery-independent sources operating along the US South Atlantic. Data sets included NFMS Headboat Survey, FL FWC fishery-dependent samples, GADNR fishery-dependent samples, and SCDNR fishery-dependent and fishery-independent samples. Length/length, weight/length, and weight/weight relationships were calculated for total length (TL), fork length (FL), standard length (SL), whole weight (WW) and gutted weight (GW) (Table 2.10.1).

## 2.11 Comments on adequacy of data for assessment analyses

The life history data provided to SEDAR24 is adequate for inputs to the assessment model.

## 2.12 Itemized list of tasks for completion following workshop

See Section 1.5

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## 2.14 Tables –refer to numbered Life History paragraphs

**Table 2.4.2.1.** Point estimates of natural mortality for red snapper and life history parameters that were used in analyses.

| Author | Natural Mortality (M) | Model Equation |
|---|---|---|
| Alverson and Carney | 0.005 | M = 3k/(exp(0.38*tmax*k)-1) |
| Hoenig | 0.08 | M=exp(1.46-1.01*ln(tmax)) (teleost) |
| | 0.08 | M=exp(1.44-0.982*ln(tmax)) (all taxa) |
| Pauly | 0.41 | M=exp(-0.0152+0.6543*ln(k)-0.279*ln(Linf, cm)+0.4634*lnT($^o$C)) |
| Ralston | 0.51 | M=0.0189+2.06*k |
| Beverton | 1.27 | M = 3k/(exp(am*k)-1) |

Parameters used in the natural mortality models. Bottom temperature was taken from Packer et al. (2003).

| Max Age | Linf_mm | Linf_cm | k | $t_0$ | Age of 50% Maturity | Temperature |
|---|---|---|---|---|---|---|
| 54 | 902 | 90.20 | 0.24 | -0.03 | 1.87 years | 17 |

**Table 2.4.2.2.** Age specific natural mortality estimated from the scaled Lorenzen (1996) model (Equation: $M=3.69*W^{-0.305}$), scaled to M = 0.08.

| Age | Scaled M | Age | Scaled M |
|---|---|---|---|
| 1 | 0.30 | 28 | 0.07 |
| 2 | 0.17 | 29 | 0.07 |
| 3 | 0.13 | 30 | 0.07 |
| 4 | 0.11 | 31 | 0.07 |
| 5 | 0.10 | 32 | 0.07 |
| 6 | 0.09 | 33 | 0.07 |
| 7 | 0.09 | 34 | 0.07 |
| 8 | 0.08 | 35 | 0.07 |
| 9 | 0.08 | 36 | 0.07 |
| 10 | 0.08 | 37 | 0.07 |
| 11 | 0.08 | 38 | 0.07 |
| 12 | 0.07 | 39 | 0.07 |
| 13 | 0.07 | 40 | 0.07 |
| 14 | 0.07 | 41 | 0.07 |
| 15 | 0.07 | 42 | 0.07 |
| 16 | 0.07 | 43 | 0.07 |
| 17 | 0.07 | 44 | 0.07 |
| 18 | 0.07 | 45 | 0.07 |
| 19 | 0.07 | 46 | 0.07 |
| 20 | 0.07 | 47 | 0.07 |
| 21 | 0.07 | 48 | 0.07 |
| 22 | 0.07 | 49 | 0.07 |
| 23 | 0.07 | 50 | 0.07 |
| 24 | 0.07 | 51 | 0.07 |
| 25 | 0.07 | 52 | 0.07 |
| 26 | 0.07 | 53 | 0.07 |
| 27 | 0.07 | 54 | 0.07 |

**Table 2.6.1.** Number of randomly sampled commercial fishing trips (# of age samples) to collected snapper landed in the US South Atlantic by year, state and gear.

| | Florida | | Georgia | | North Carolina | | South Carolina | | | | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **Diver** | **Hook and Line** | **Diver** | **Hook and Line** | **Hook and Line** | **Traps** | **Unknown** | **Diver** | **Hook and Line** | **HL/Diver** | **Traps** | **Trawls** | **# of Samples** |
| **1979** | | | | | | | 2 (6) | | 5 (39) | | | 2 (19) | 64 |
| **1980** | | | | 1 (2) | | | | | 4 (9) | | | 1 (5) | 16 |
| **1981** | | | | | | | | | 1 (1) | | | | 1 |
| **1986** | | | | | | | 1 (7) | | | | | | 7 |
| **1988** | | | | | | | | | 9 (38) | | 1 (5) | | 43 |
| **1989** | | | | | | | | | 7 (9) | | 1 (1) | | 10 |
| **1990** | | | | | | | | | 12 (28) | | | | 28 |
| **1991** | | | | | | | | | 7 (24) | | 3 (5) | | 29 |
| **1992** | | 3 (16) | | | | | | | 15 (33) | | | | 49 |
| **1993** | | 1 (7) | | | | | | | 12 (30) | | | | 37 |
| **1994** | | 1 (1) | | | | | | | 22 (48) | | | | 49 |
| **1995** | | 2 (16) | | | | | 1 (4) | | 8 (12) | | | | 32 |
| **1996** | | 18 (131) | | 1 (8) | | | | | 17 (39) | | | | 178 |
| **1997** | | 16 (64) | | 1 (5) | | | | | 39 (139) | | | | 208 |
| **1998** | | 16 (57) | | | | | | | 2 (23) | | | | 80 |
| **1999** | | 5 (13) | | | | | | | 10 (155) | | | | 168 |
| **2000** | 6 (137) | 8 (105) | | 2 (28) | | | | 1 (1) | 13 (173) | | | | 444 |
| **2001** | 1 (16) | 21 (155) | 2 (35) | | | | | | | | | | 206 |
| **2002** | | 7 (37) | | | | | | | 2 (3) | | | | 40 |
| **2003** | | 9 (49) | | | 1 (2) | | | | | | | | 51 |
| **2004** | | 8 (66) | | | 22 (39) | | | | | | | | 105 |
| **2005** | | 7 (47) | | | 37 (62) | | | | 12 (34) | | | | 143 |
| **2006** | | 8 (54) | | | 30 (44) | | | 1 (1) | 50 (119) | | | | 218 |
| **2007** | 1 (1) | 14 (87) | | | 55 (92) | | | 1 (3) | 70 (114) | | 1 (1) | | 298 |
| **2008** | | 7 (60) | | | 69 (174) | 2 (2) | | | 86 (205) | | 1 (1) | | 442 |
| **2009** | 14 (47) | 116 (2219) | | | 56 (162) | | 2 (2) | 4 (9) | 111 (283) | 1 (3) | | | 2725 |

**Table 2.6.2**. Number of randomly sampled recreational fishing trips (# of age samples) to collect snapper landed in the US South Atlantic by year, state and sector.

| | North Carolina | South Carolina | Georgia | | | Florida | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Headboat | Headboat | Headboat | Charter Boat | Private | Headboat | Charter Boat | Private | Unidentified Recreational |
| 1977 | | 5 (12) | | | | 17 (62) | | | |
| 1978 | 1 (1) | 2 (2) | 3 (4) | | | 78 (276) | | | |
| 1979 | | 1 (1) | | | | 31 (46) | | | |
| 1980 | 2 (2) | 4 (6) | | | | 31 (90) | | | |
| 1981 | 3 (3) | | | | | 144 (424) | | | |
| 1982 | 1 (3) | | | | | 56 (133) | | | |
| 1983 | 2 (3) | 4 (5) | | | | 168 (766) | | | |
| 1984 | | 20 (30) | | | | 159 (609) | | | |
| 1985 | | 10 (13) | | | | 156 (527) | | | |
| 1986 | 1 (2) | 4 (8) | 1 (1) | | | 95 (187) | | | |
| 1987 | 1 (1) | | | | | 67 (100) | | | |
| 1988 | 4 (4) | | | | | 17 (19) | | | |
| 1989 | 4 (11) | 17 (23) | | | | 11 (26) | | | |
| 1990 | 6 (11) | 3 (4) | | | | 14 (22) | | | |
| 1991 | 5 (5) | 2 (2) | | | | 14 (21) | | | |
| 1992 | 4 (6) | 2 (3) | | | | 4 (4) | | | |
| 1993 | 2 (2) | 6 (9) | | | | 6 (9) | | | |
| 1994 | 3 (5) | 1 (1) | | | | 6 (9) | 2 (10) | | |
| 1995 | 2 (3) | 1 (1) | | | | 8 (15) | | | |
| 1996 | 3 (3) | 36 (89) | 1 (1) | | | 19 (32) | | | |
| 1997 | | | | | | 13 (16) | | | |
| 1998 | | | | | | 6 (8) | | | |
| 1999 | | | | | | | | | |
| 2000 | | | | | | 2 (2) | 1 ( 3) | | |
| 2001 | | | | | | 2 (2) | 26 (75) | 1 ( 2) | |
| 2002 | | 4 (4) | | | | 4 (10) | 94 (400) | | 2 ( 2) |
| 2003 | 1 (1) | 1 (1) | | | | 6 (15) | 76 (397) | | |
| 2004 | 3 (3) | | | | | 8 (25) | 69 (314) | 1 ( 3) | |
| 2005 | 2 (5) | 1 (1) | | | | 8 (12) | 67 (261) | | |
| 2006 | 3 (3) | 8 (8) | 3 (3) | | | 13 (20) | | | |
| 2007 | 1 (1) | 12 (12) | 4 (4) | | | 24 (67) | 11 (29) | 1 ( 2) | |
| 2008 | 6 (10) | 4 (6) | 1 (1) | | | 44 (148) | | | |
| 2009 | 8 (9) | 10 (16) | 55 (628) | 26 (196) | 4 (60) | 218 (1018) | 56 (327) | 7 (20) | |

**Table 2.6.1.1.** Red snapper aging error matrix from the ages determined by NMFS, Florida, and MARMAP.

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.88 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1 | 0.12 | 0.75 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 0.00 | 0.12 | 0.72 | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | 0.00 | 0.00 | 0.14 | 0.69 | 0.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4 | 0.00 | 0.00 | 0.00 | 0.15 | 0.66 | 0.18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.17 | 0.64 | 0.18 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 6 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 0.62 | 0.19 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 0.61 | 0.20 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.59 | 0.20 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.20 | 0.58 | 0.21 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.20 | 0.57 | 0.21 | 0.01 | 0.00 | 0.00 | 0.00 |
| 11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.21 | 0.55 | 0.21 | 0.01 | 0.00 | 0.00 |
| 12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.21 | 0.55 | 0.22 | 0.02 | 0.00 |
| 13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.21 | 0.54 | 0.22 | 0.02 |
| 14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.22 | 0.53 | 0.22 |
| 15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.22 | 0.52 |
| 16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.22 |
| 17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| 18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 2.6.1.1. continued**

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 36 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 37 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 41 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 44 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 47 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 48 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 53 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 54 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 2.6.1.1. continued**

| 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.22 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.52 | 0.23 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.22 | 0.51 | 0.23 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.02 | 0.23 | 0.51 | 0.23 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.02 | 0.23 | 0.50 | 0.23 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.02 | 0.23 | 0.50 | 0.23 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.02 | 0.23 | 0.49 | 0.23 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.23 | 0.49 | 0.23 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.23 | 0.49 | 0.23 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.23 | 0.49 | 0.23 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.23 | 0.48 | 0.23 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.23 | 0.48 | 0.23 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.23 | 0.48 | 0.23 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 2.6.1.1. continued**

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.23 | 0.48 | 0.23 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.23 | 0.47 | 0.23 | 0.03 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.23 | 0.47 | 0.23 | 0.03 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.23 | 0.47 | 0.23 | 0.03 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.23 | 0.47 | 0.24 | 0.03 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.23 | 0.47 | 0.24 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.47 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 2.6.1.1. continued**

| 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 2.6.1.1. continued**

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.47 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.24 | 0.47 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.03 | 0.24 | 0.47 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 | 0.03 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.24 | 0.46 | 0.24 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.27 | 0.73 |

**Table 2.7.1:** von Bertalanffy growth curves for male and female Atlantic red snapper, uncorrected for minimum size limit bias. The p-value is the calculated p-value from Kimura's (1980) likelihood ratio test while AIC and BIC refer to the AIC and BIC values calculated for sexes combined and sexes separate growth models, respectively.

| Group | n | $L_\infty$ | K | t0 | p-value | AIC | BIC |
|---|---|---|---|---|---|---|---|
| Male | 1931 | 926 | 0.176 | -1.830 | 0.44 | 45450 vs. 45447 | 45494 vs 45472 |
| Female | 2007 | 956 | 0.156 | -2.176 | | | |

**Table 2.7.2:** von Bertalanffy growth curves for the North and South region, uncorrected for minimum size limit bias. The p-value is the calculated p-value from Kimura's (1980) likelihood ratio test while AIC and BIC refer to the AIC and BIC values calculated for regions combined and regions separate growth models, respectively.

| Region | n | $L\infty$ | K | t0 | p-value | AIC | BIC |
|---|---|---|---|---|---|---|---|
| North | 2416 | 902 | 0.184 | -1.876 | <0.001 | 144414 v 144608 | 144466 v 144638 |
| South | 10429 | 907 | 0.231 | -0.689 | | | |

**Table 2.8.2.1.** Percentage of mature red snapper by size class from 1977 – 2009.

| | Female | | Male | |
|---|---|---|---|---|
| **TL** | **% Mature** | *n* | **% Mature** | *n* |
| <=250 | 0 | 19 | 50 | 10 |
| 251-300 | 15.79 | 19 | 86.21 | 29 |
| 301-350 | 28.57 | 28 | 87.5 | 32 |
| 351-400 | 50.82 | 61 | 95.16 | 62 |
| 401-450 | 90 | 70 | 98.39 | 62 |
| 451-500 | 100 | 47 | 100 | 39 |
| 501-550 | 100 | 144 | 100 | 130 |
| 551-600 | 100 | 101 | 100 | 109 |
| 601-650 | 100 | 49 | 100 | 39 |
| 651-700 | 100 | 20 | 100 | 17 |
| 701-750 | 100 | 29 | 100 | 17 |
| 751-800 | 100 | 16 | 100 | 12 |
| 801-850 | 100 | 5 | 100 | 5 |
| 851-900 | 100 | 8 | 100 | 3 |
| 901-950 | 100 | 3 | 100 | 0 |
| 951-1000 | 100 | 1 | 100 | 0 |
| **Totals** | | **620** | | **566** |

**Table 2.8.3.1.** Chi-square analysis of sex ratios for adult red snapper by Total Length (TL, mm) from 1977 – 2009. $H_o$: Male to Female is 1:1. *$p < 0.01$ **$p < 0.05$

| TL | Female | Male | Sex Ratio (M:F) | $X^2$ |
|---|---|---|---|---|
| <=250 | 0 | 5 | | |
| 251-300 | 3 | 25 | 1:0.1 | 8.64* |
| 301-350 | 9 | 28 | 1:0.3 | 4.88** |
| 351-400 | 34 | 61 | 1:0.6 | 3.84** |
| 401-450 | 64 | 61 | 1:1.1 | 0.04 |
| 451-500 | 48 | 39 | 1:1.2 | 0.47 |
| 501-550 | 144 | 131 | 1:1.1 | 0.31 |
| 551-600 | 105 | 110 | 1:1 | 0.06 |
| 601-650 | 54 | 41 | 1:1.3 | 0.89 |
| 651-700 | 22 | 18 | 1:1.2 | 0.20 |
| 701-750 | 29 | 17 | 1:1.7 | 1.57 |
| 751-800 | 17 | 13 | 1:1.3 | 0.27 |
| 801-850 | 5 | 5 | 1:1 | 0.00 |
| 851-900 | 8 | 3 | 1:2.7 | 1.14 |
| 901-950 | 3 | 1 | 1:3 | 0.50 |
| 951-1000 | 1 | 0 | | 0.50 |
| **Total** | **546** | **558** | **1:1** | **0.07** |

**Table 2.8.3.2.** Chi-square analysis of sex ratios for adult red snapper by year, 1977 – 2009. $H_o$: Male to Female is 1:1.

| Year | Female | Male | Sex Ratio (M:F) | $X^2$ |
|---|---|---|---|---|
| 1977 | 0 | 0 | | |
| 1978 | 2 | 1 | 1:2 | 0.17 |
| 1979 | 8 | 2 | 1:4 | 1.80 |
| 1980 | 9 | 4 | 1:2.3 | 0.96 |
| 1981 | 3 | 5 | 1:0.6 | 0.25 |
| 1982 | 1 | 0 | | |
| 1983 | 0 | 0 | | |
| 1984 | 9 | 9 | 1:1 | 0.00 |
| 1985 | 0 | 0 | | |
| 1986 | 1 | 0 | | |
| 1987 | 0 | 1 | | |
| 1988 | 17 | 20 | 1:0.9 | 0.12 |
| 1989 | 4 | 3 | 1:1.3 | 0.07 |
| 1990 | 7 | 16 | 1:0.4 | 1.76 |
| 1991 | 0 | 12 | | |
| 1992 | 12 | 13 | 1:0.9 | 0.02 |
| 1993 | 18 | 12 | 1:1.5 | 0.60 |
| 1994 | 23 | 28 | 1:0.8 | 0.25 |
| 1995 | 8 | 6 | 1:1.3 | 0.14 |
| 1996 | 17 | 10 | 1:1.7 | 0.91 |
| 1997 | 39 | 28 | 1:1.4 | 0.90 |
| 1998 | 21 | 23 | 1:0.9 | 0.05 |
| 1999 | 75 | 87 | 1:0.9 | 0.44 |
| 2000 | 197 | 186 | 1:1.6 | 0.16 |
| 2001 | 26 | 23 | 1:1.1 | 0.09 |
| 2002 | 9 | 19 | 1:0.5 | 1.79 |
| 2003 | 0 | 0 | | |
| 2004 | 0 | 4 | | |
| 2005 | 7 | 6 | 1:1.2 | 0.04 |
| 2006 | 1 | 4 | 1:0.3 | 0.90 |
| 2007 | 15 | 17 | 1:0.9 | 0.06 |
| 2008 | 12 | 14 | 1:0.9 | 0.08 |
| 2009 | 10 | 9 | 1:1.1 | 0.03 |
| **Total** | **551** | **562** | **1:1** | **0.05** |

**Table 2.8.3.3.** Chi-square analysis of sex ratios for red snapper by age (year), 1977 – 2009. $H_o$: Male to Female is 1:1. *p < 0.10, **p < 0.05

| Age | Female | Male | Sex Ratio (M:F) | $X^2$ |
|---|---|---|---|---|
| 0 | 0 | 0 | | |
| 1 | 0 | 1 | | |
| 2 | 44 | 75 | 1: | 4.04** |
| 3 | 194 | 197 | 1:0.6 | 0.01 |
| 4 | 144 | 163 | 1:0.9 | 0.59 |
| 5 | 51 | 36 | 1:1.4 | 1.29 |
| 6 | 24 | 18 | 1:1.3 | 0.43 |
| 7 | 17 | 5 | 1:3.4 | 3.27* |
| 8 | 4 | 6 | 1:0.7 | 0.20 |
| 9 | 5 | 3 | 1:1.7 | 0.25 |
| 10 | 5 | 3 | 1:1.7 | 0.25 |
| 11 | 2 | 0 | | |
| 12 | 1 | 0 | | |
| 18 | 1 | 0 | | |
| 19 | 1 | 0 | | |
| 22 | 1 | 0 | | |
| 23 | 1 | 0 | | |
| 27 | 0 | 1 | | |
| 28 | 1 | 0 | | |
| 35 | 0 | 1 | | |
| 36 | 1 | 0 | | |
| 38 | 1 | 0 | | |
| 46 | 0 | 1 | | |
| **Total** | **498** | **510** | 1:1 | 0.07 |

**Table 2.10.1.** US South Atlantic red snapper meristic conversions.

| Regression Equation | n | $r^2$ | Range | | | |
|---|---|---|---|---|---|---|
| TL = 3.77473 + 1.05992*FL | 3,275 | 99.5% | TL range | 70 - 976 | FL range | 64 - 942 |
| TL = 16.3669 + 1.23047*SL | 1,492 | 99.4% | TL range | 70 - 976 | SL range | 54 - 825 |
| FL = -1.07382 + 0.938899*TL | 3,275 | 99.5% | FL range | 64 - 942 | TL range | 70 - 976 |
| FL = 14.5046 + 1.15125*SL | 1,438 | 99.4% | FL range | 64 - 942 | SL range | 54 - 825 |
| SL = -10.7205 + 0.807653*TL | 1,492 | 99.4% | SL range | 54 - 825 | TL range | 70 - 976 |
| SL = -10.3081 + 0.863854*FL | 1,438 | 99.5% | SL range | 54 - 825 | FL range | 64 - 942 |
| TotWW = 1.076*GutWW | 30 | 99.9% | TotWW range | 1,740 - 11,500 | GutWW range | 1,590 - 10,800 |
| TotWW = 0.00000715386*TL^3.11796 | 2,520 | 96.2% | TotWW range | 12 - 15,090 | TL range | 90 - 947 |
| TotWW = 0.0000111897*FL^3.07891 | 2,450 | 97.0% | TotWW range | 12 - 15,090 | FL range | 86 - 902 |
| TotWW = 0.0000722071*SL^2.86328 | 996 | 97.6% | TotWW range | 12 - 15,090 | SL range | 73 - 772 |

TL=Total length in mm

FL=Fork length in mm

SL=Standard length in mm

TotWW=Total wet weight in grams

GutWW=Gutted wet weight in grams

## 2.15 Figures – refer to numbered Life History paragraphs

**Figure 2.6.1.1.** The MARMAP age estimate compared to an average age estimate for the samples from the SC DNR reference collection. The average age is the average from NMFS, FL, and GA, and the line is the 1:1 line.

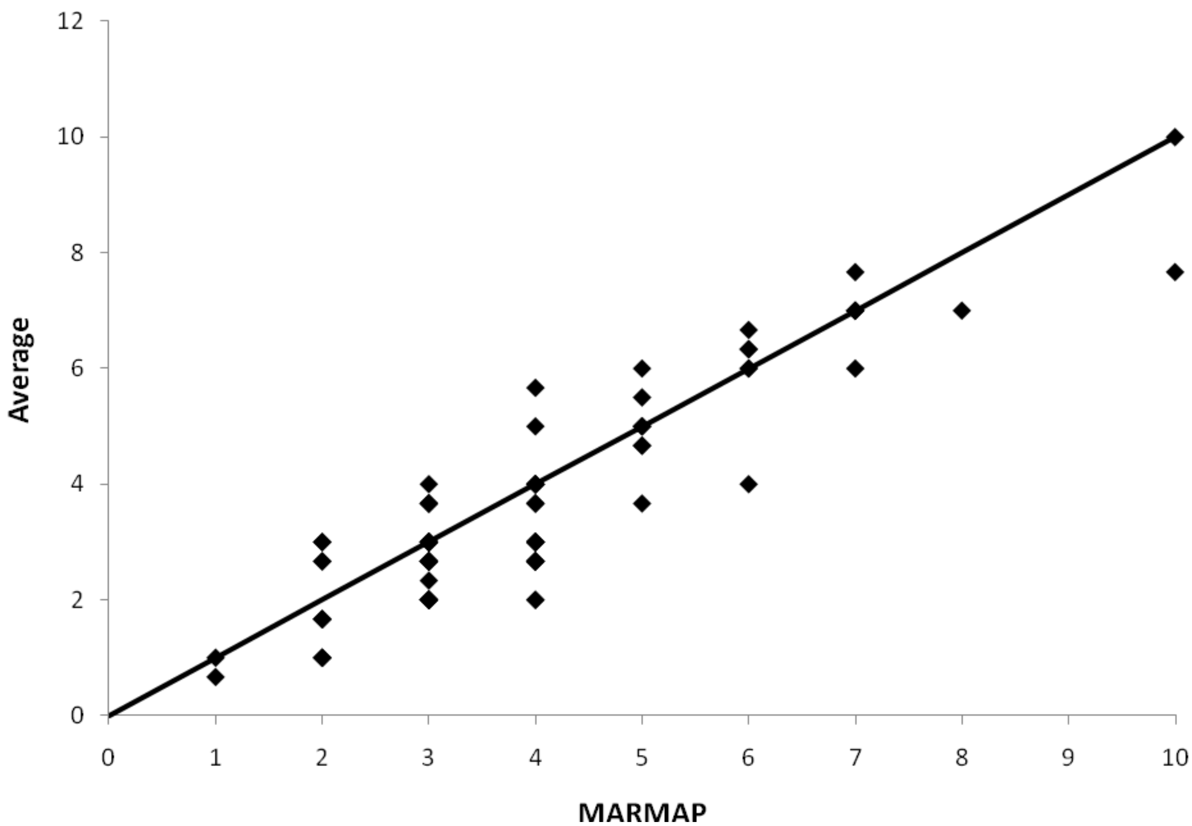


**Figure 2.6.1.2.** The estimated standard deviation (SD) and coefficient of variation (CV) for south Atlantic red snapper using data from paired age estimates and the program agemat.

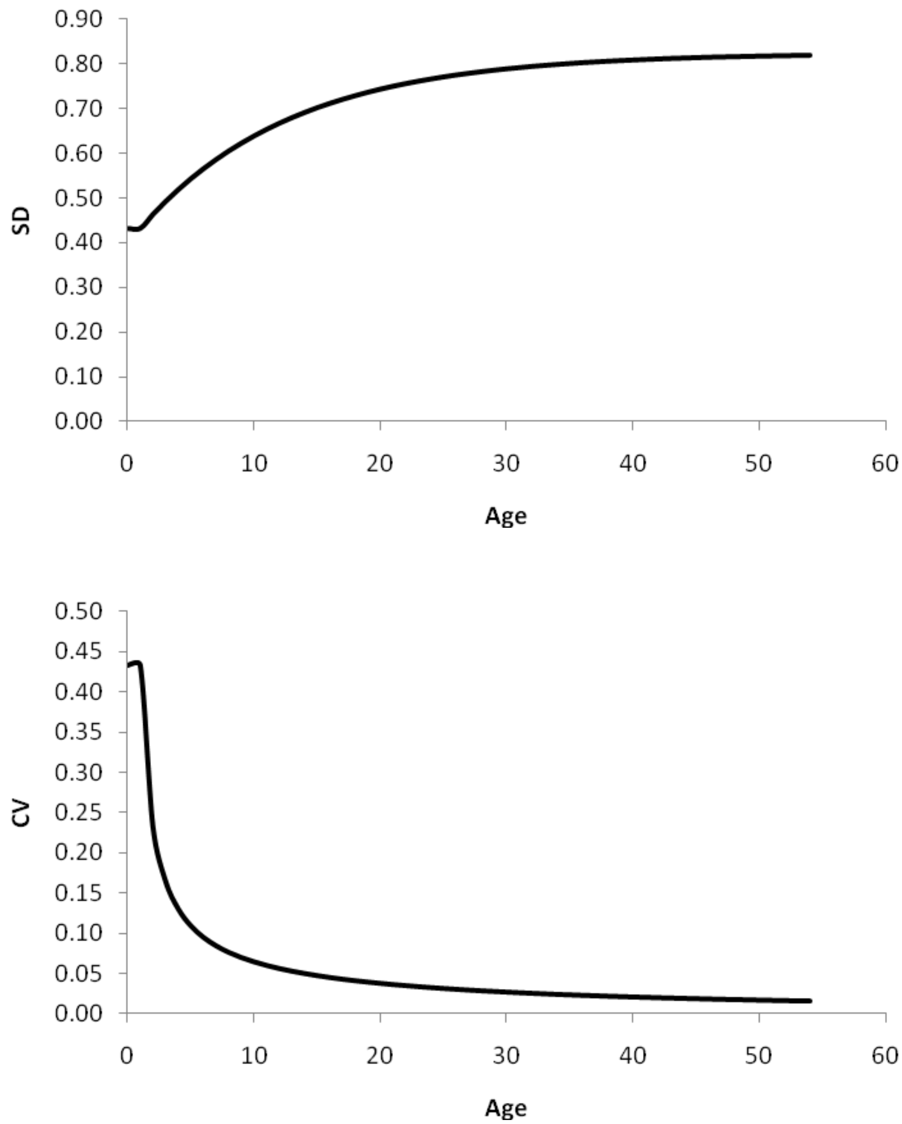
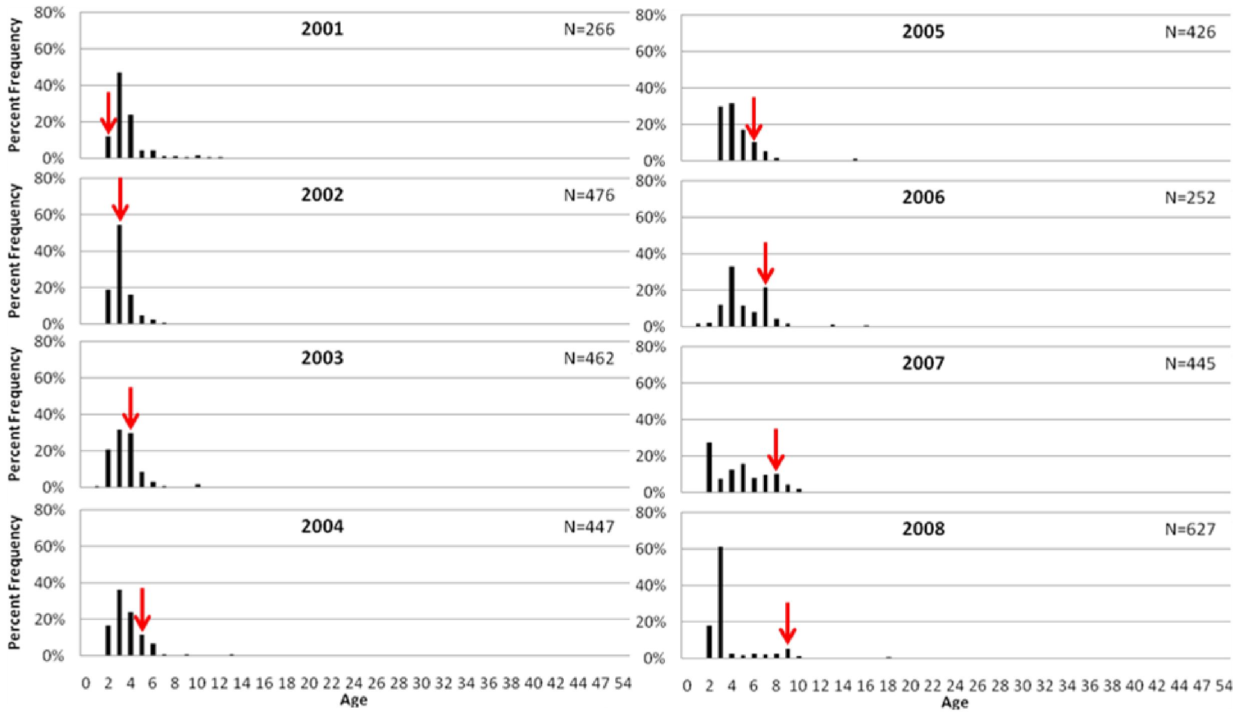


**Figure 2.6.2.1.** 1999 (a) year class and 2005 (b) year class of US South Atlantic red snapper.

a.




b.

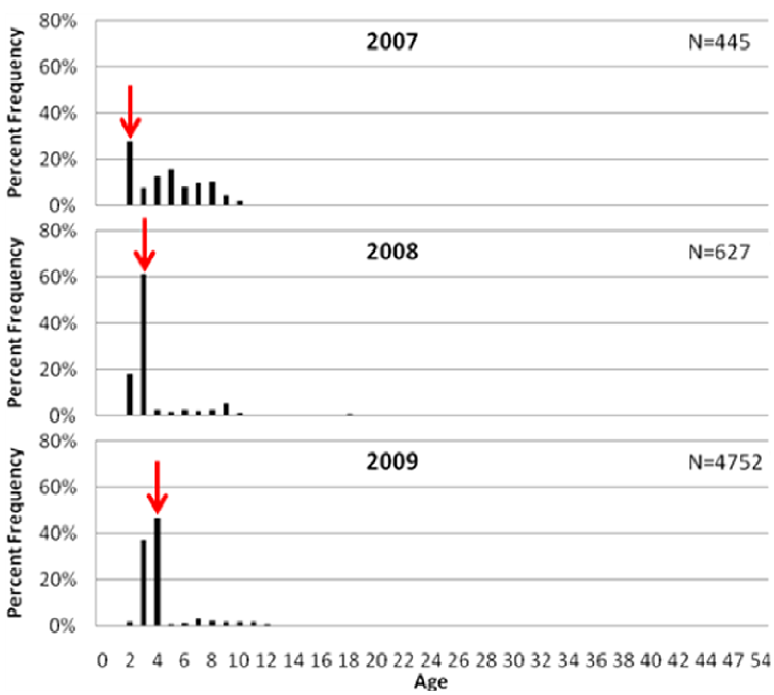


**Figure 2.7.1:** Region specific von Bertalanffy growth models for Atlantic red snapper, uncorrected for minimum size limit size bias.

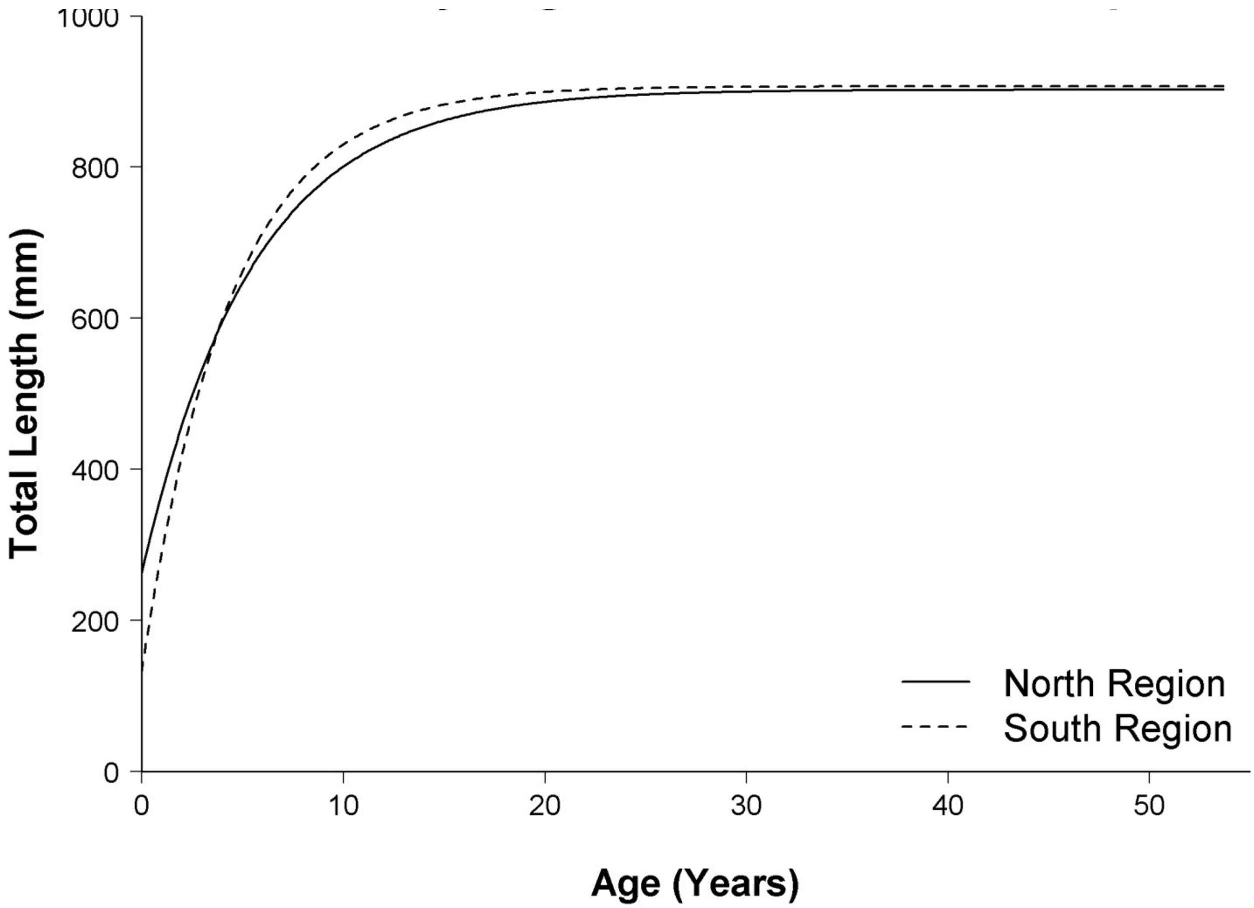


**Figure 2.7.2**: Fishery type specific von Bertalanffy growth curve for Atlantic red snapper, uncorrected for minimum size limit size bias.

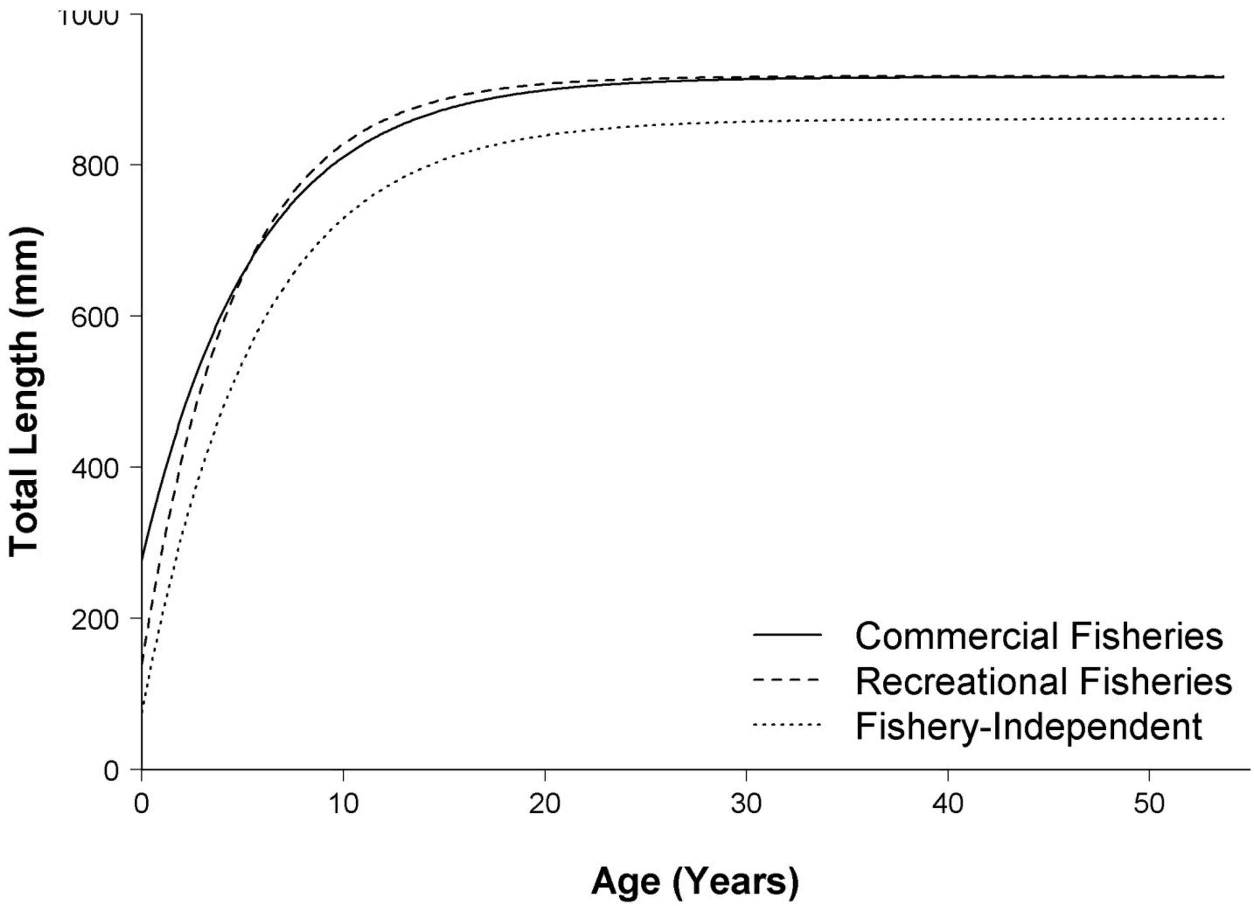


**Figure 2.7.3**: von Bertalanffy growth model developed for Atlantic red snapper collected via fishery-independent sampling, uncorrected for minimum size limit size bias.

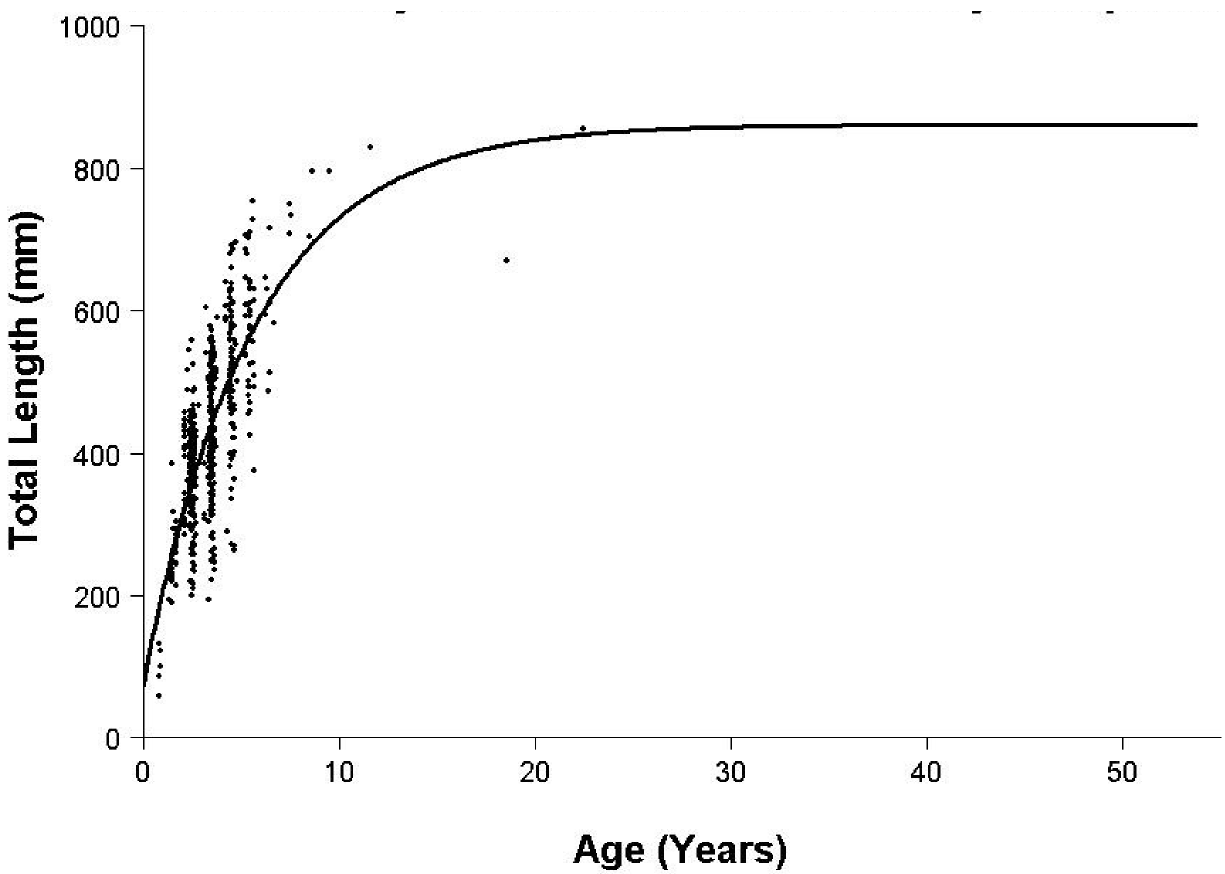


**Figure 2.7.4:** von Bertalanffy growth model for all data combined, corrected for minimum size limit size bias (Diaz et al. 2004). Dark (or black) diamonds represent fishery-dependent age samples. Light (or yellow) diamonds represent fishery-independent age samples.

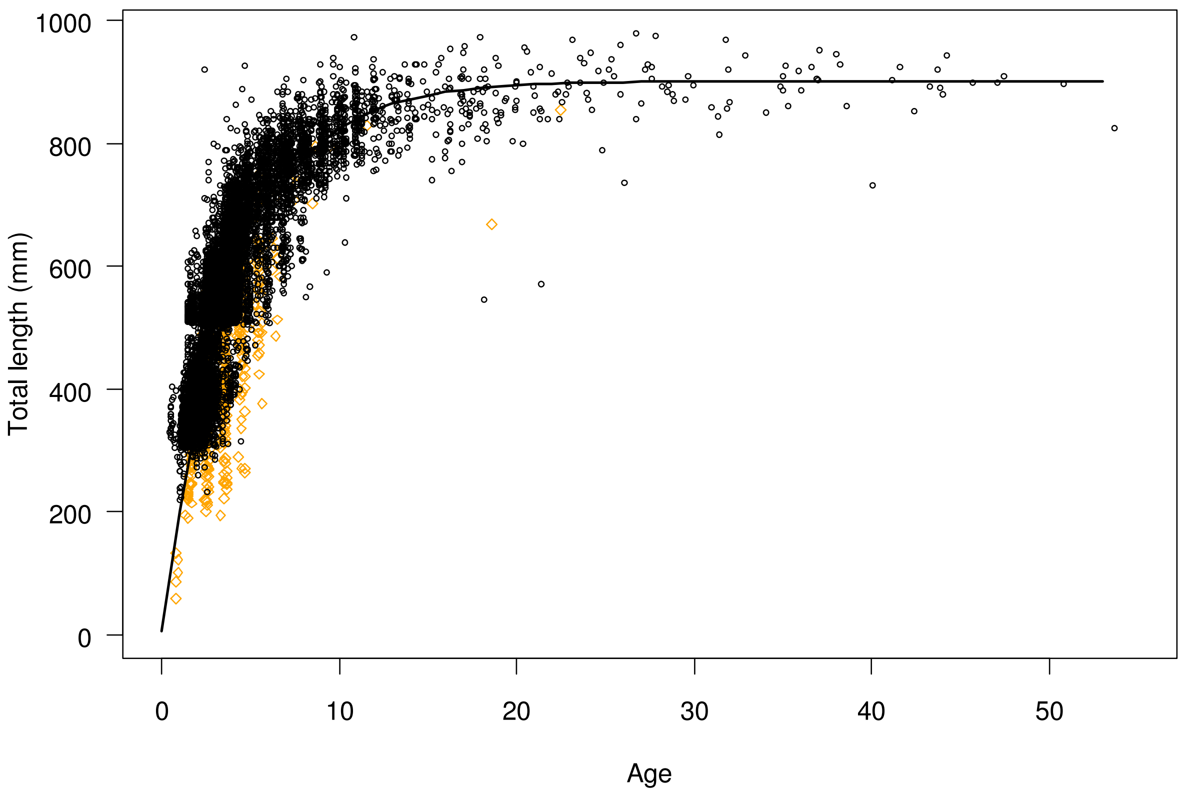


**Figure 2.7.5:** Comparison of Gulf of Mexico and South Atlantic red snapper von Bertalanffy growth curve.

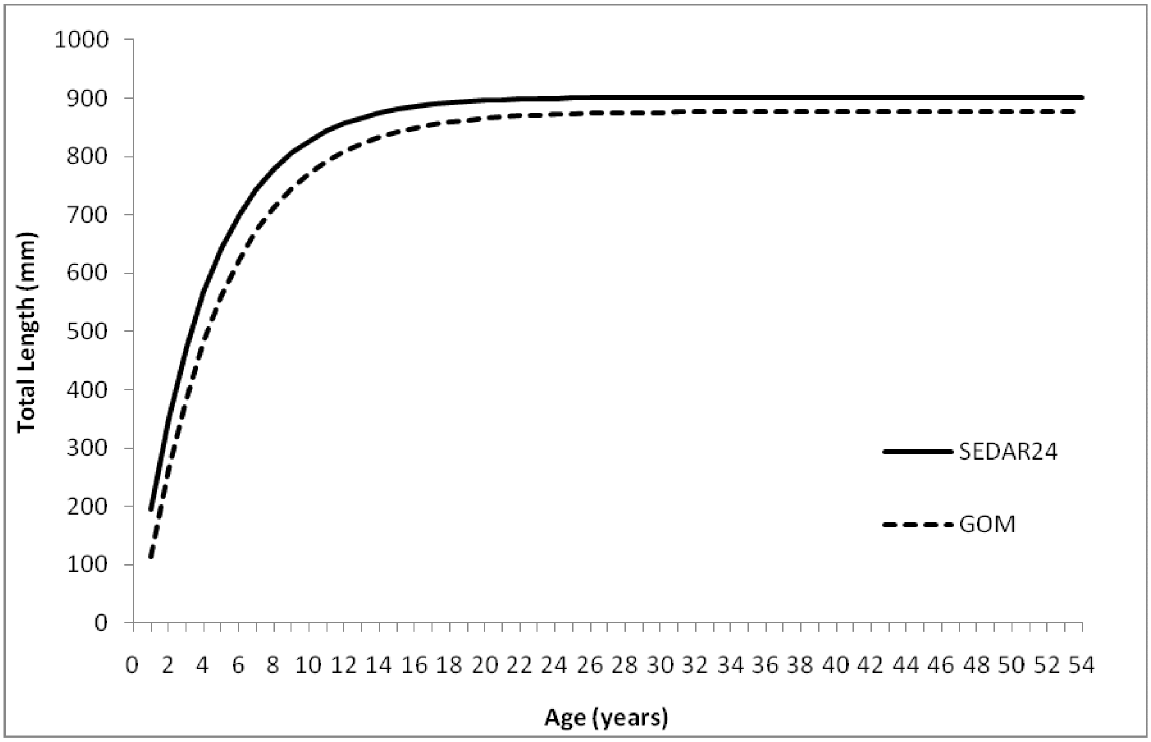
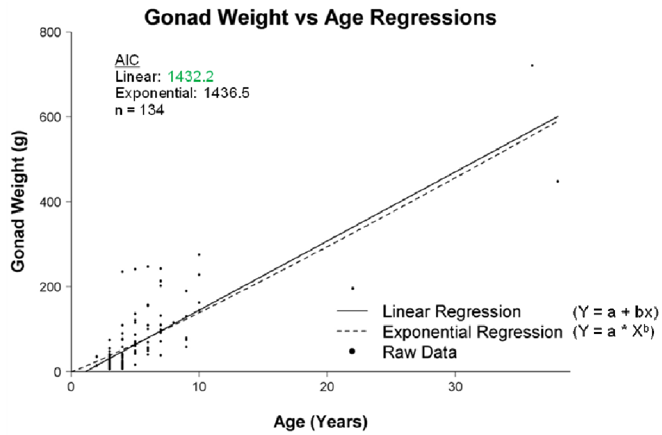
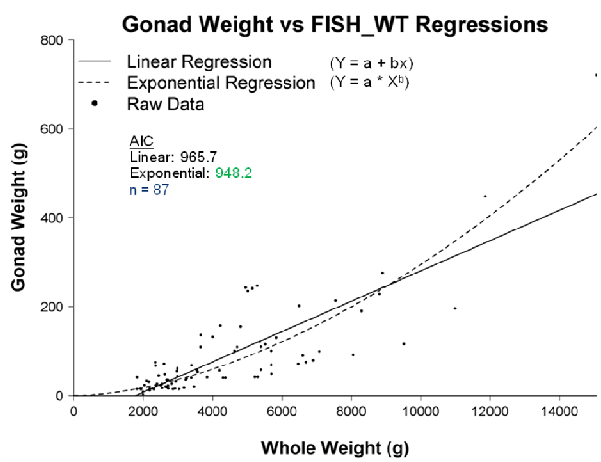


**Figure 2.8.5.1.** Three proxies to estimate red snapper fecundity that were generated from MARMAP data. A) Gonad weight vs. calendar age, B) Gonad weight vs. whole fish weight, and C) Gonad weight vs. total length (TL).

A)




B)




C)

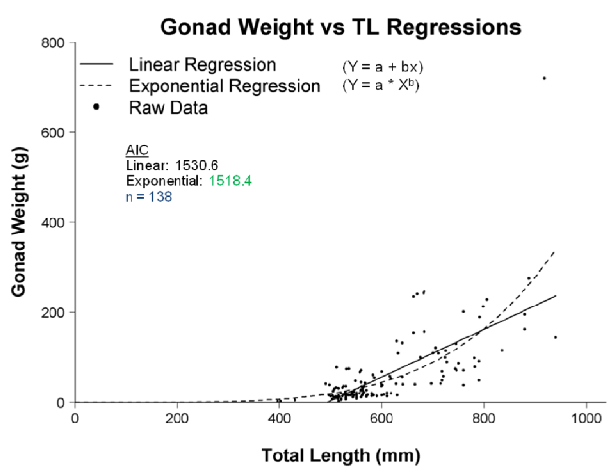
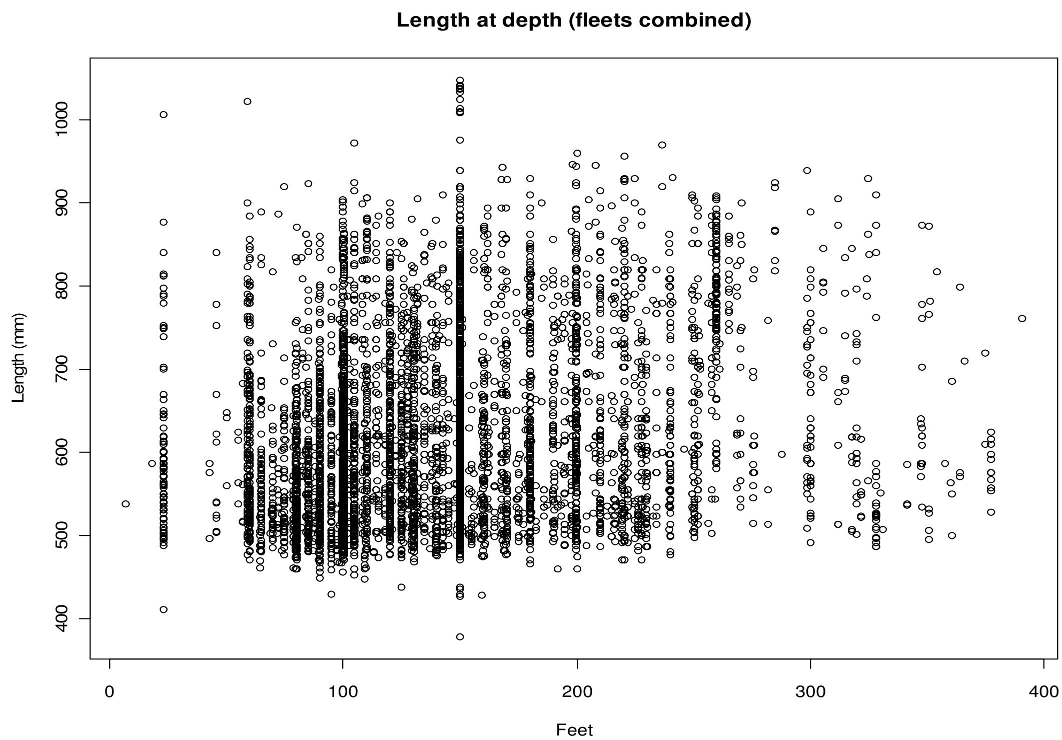
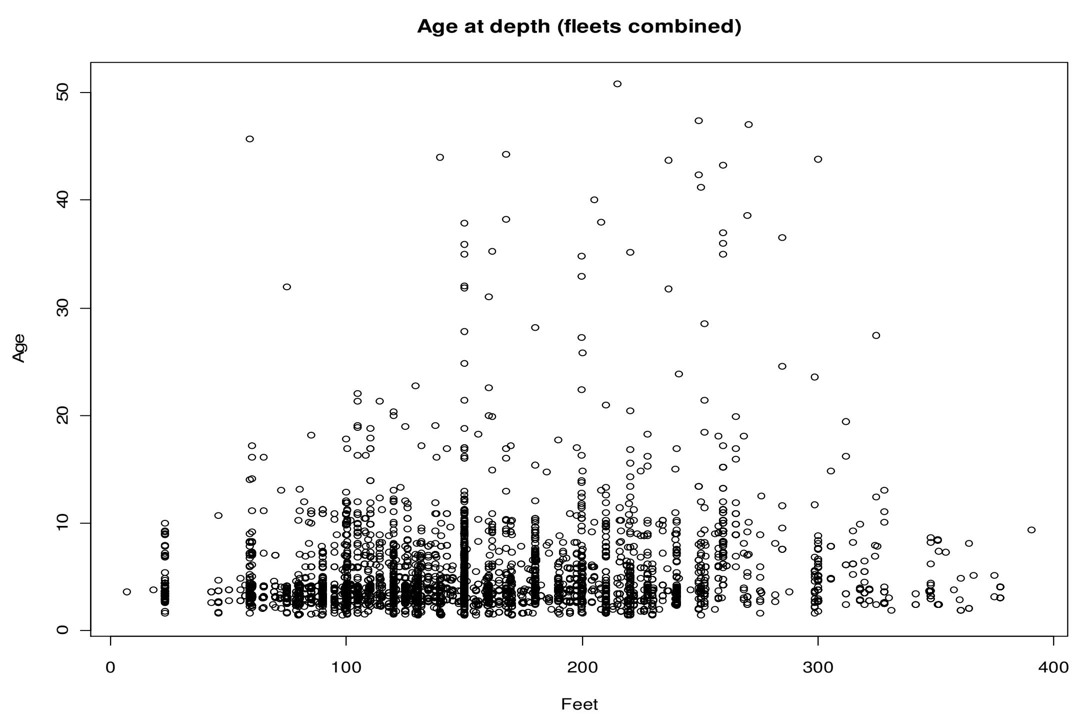


**Figure 2.9.1**. Depth distribution of US South Atlantic red snapper by a) size (TL mm) and b) age.

a.




b.



# 3. Commercial Fishery Statistics

## 3.1 Overview

Topics discussed by the Commercial Workgroup began with a discussion of stock boundaries, both the southern boundary with the Gulf of Mexico and the northern boundary (north of North Carolina).

To develop annual landings by gear and state, no adjustments were deemed necessary for misidentification of red snapper with other snapper species or inclusion of unclassified snappers that would have been analogous to SEDAR assessments for other snapper-grouper species. Commercial landings for the U.S. South Atlantic red snapper stock were developed by gear (handline and diving) in whole weight for the period 1950 through 2009 based on federal and state data bases. Intermittent landings estimates from historical reports were also consulted for 1902-1949. Corresponding landings in numbers were estimated from mean weights estimated from TIP by gear, state and year for 1950-2009.

Discards, developed from the snapper-grouper logbook, were estimated for recent years (1992-2009) subsequent to the last change in minimum size limit for red snapper along the U.S. South Atlantic coast. Limited observer discard data (2007-2009) permitted development of length composition of discarded red snapper, and estimation of discard mortality from a depth-mortality relationship adopted by the plenary for commercial handlines.

Sampling intensity for lengths and age by gear, state and year were considered, and length and age compositions were developed by gear and year for which sample size was deemed adequate.

Other topics discussed during this workshop included consideration of market category for post-stratification of length composition data, and discussion of selectivity appropriate for handline gear. Several research recommendations were updated and amended from SEDAR 15.

### 3.1.1 Participants in SEDAR 24 Data Workshop Commercial Workgroup:

Douglas Vaughan, NMFS, Beaufort, NC (leader)
Stephanie McInerney, NC DMF, Morehead City, NC (rapporteur)
Steve Brown, FL MRRI, St. Petersburg, FL
Julie Defilippi, ACCSP, Washington, DC
Kenny Fex, Commercial Fisherman, NC
David Gloeckner, NMFS, Beaufort, NC
Jack Holland, NC DMF, Wilmington, NC
Kevin McCarthy, NMFS, Miami, NC
Dave Player, SC DMF, Charleston, SC

### 3.1.2 Preliminary Commercial Gears Considered

In preparation for the SEDAR 24 Data Workshop, the commercial working group settled on the following numerical gear codes (ALS) for dividing red snapper commercial landings into six categories for consideration by the Workgroup. These gears included:

Handline (600-616, 660, 665),

Longline (675-677),

Diving (760, 941-943),

Trawl (200-220),

Traps (325-390), and

Other (remaining gear codes including unknown).

Although reported separately here, the small quantities of longline, trawl, and trap landings were pooled with “other” gear type, which in turn was pooled with handlines, the dominant gear (see **Decision 6**).

### 3.1.3 Stock Boundaries

**Data Workshop Term of Reference #1**: Review stock structure and unit stock definitions and consider whether changes are required. **(Decisions 1 & 2)**

Initial discussion and decisions concerned setting the geographic boundaries for the south Atlantic red snapper stock. Landings were obtained from the states north of North Carolina (ACCSP). Prior to 1987, reported red snapper landings were infrequent, occurring only in 1950 (300 lbs whole weight), 1970 (300 lbs), and 1983 (100 lbs). Landings became more frequent beginning in 1987, with positive landings for 1987-1988, 1992-1999, 2001-2002, 2004, and 2007. If we assume landings were truly 0 in those years none were reported for 1950-2008, then the average annual reported landings of red snapper from north of North Carolina was 46 pounds (whole weight). If we just compute the average landings beginning in 1987, we obtain 92 pounds.

#### 3.1.3.1 Decision 1.

Because very few red snapper landings were reported north of North Carolina, the Workgroup recommends using the VA/NC line as the northern boundary for the South Atlantic red snapper stock. This decision was approved by the plenary.

The Commercial Workgroup considered several approaches for splitting the Atlantic and Gulf of Mexico stocks. Monroe County, Florida, has been the focal point for the stock boundary between the U.S. South Atlantic and Gulf of Mexico waters. During SEDAR 15, the Workgroup chose an approach that paralleled that of the last Gulf of Mexico red snapper assessment (SEDAR 7). All Florida landings with water body codes 0010, 0019, 0029, and 7xxx and higher, with exception of 7441 and 7481 (Florida Bay), were considered South Atlantic catch. Also included were the small amount of landings from state 12 which represent Florida interior counties landed on Florida east coast. If water body code was unknown (0 or 9999) it was retained for state 10 (Florida, Atlantic coast), but deleted for state 11 (Florida, Gulf coast). See maps showing shrimp statistical areas for the Gulf of Mexico and U.S. Atlantic coasts (Figure 3.1) and Florida statistical areas (Figure 3.2). For detailed description of the Accumulated Landing System (ALS), see Addendum 3.1 to this section. For the years 1992-2009 water body and jurisdiction allocations are based on water body ratios as reported in the Fishery Logbook data and applied to the landings by gear reported in the ALS as in SEDAR 15 for Monroe County. The group consensus was data reported directly by fishermen in the logbook program versus data reported third person by dealers and associated staff submitted to the states/ALS would be more precise in assigning area of capture to catch.

The Commercial Workgroup discussed alternative approaches for splitting landings between the South Atlantic and Gulf of Mexico. We decided to go with what was in SEDAR 15 because the differences using the Dade/Monroe County line were greater than 5% (CV) in some years. Furthermore, there were small differences between Florida Trip Ticket and ALS (less than 1%), so we continue to use the ALS data as the basis for Florida landings. As in SEDAR 15, this method essentially does the complementary calculation for what was used in the Gulf of Mexico Red Snapper Assessment (SEDAR 7).

#### 3.1.3.2 Decision 2.

The Workgroup recommends application of the same approach for dividing red snapper into South Atlantic and Gulf of Mexico stocks as for the previous red snapper assessment (SEDAR 15). This decision was approved by the plenary.

## 3.2 Review of Working Papers Assigned to Commercial Workgroup

**SEDAR24-DW01:** The analyses contained in this report are based on self-reporting of discards in the commercial logbook data base. Two methods were presented to the Commercial Workgroup for discussion. Section 3.3.1 contains a summary of this report and the discussion and conclusions of the Commercial Workgroup that it generated. The results of these analyses were accepted by the Commercial Workgroup and the Plenary as best available data for estimating discards from the commercial handlines.

**SEDAR24-DW08:** This report presents a description of the Trip Interview Program (TIP) of NMFS. TIP is not specific to red snapper and is intended to provide sampling coverage for all species. This data base is the primary source of lengths as sampled from commercial gears with concomitant trip information. See section 3.4 on biological sampling.

**SEDAR24D-W09:** This report provided a framework for discussions by the Commercial Workgroup during the SEDAR 24 Data Workshop. For this preliminary report, red snapper landings from NMFS Accumulated Landing System (ALS) were used in the tables and figures for 1962-2009. This report will not be updated following Data Workshop, but instead is superseded by the Commercial Section 3 of the Data Workshop Report (this report).

## 3.3 Characterizing Commercial Landings

**Data Workshop Term of Reference #8:** Characterize commercial and recreational catch, including both landings and discards in both pounds and number. Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector. Provide observed length and age distributions if feasible. Provide maps of fishery effort and harvest. Provide a written description of the discard sampling programs. (Decisions 3-8)

### 3.3.1 Mis-identification and Unclassified Snappers

The next topics of discussion included whether misidentification of red snapper with other snapper species was a concern and whether red snapper landings may be incorporated in significant quantities in the unclassified snapper category. Neither of these issues was considered significant by the SEDAR 15 Commercial Workgroup. The Commercial WG discussed and agreed with this decision. There are similar species to red snapper being landed but markets and regulations are different so there should be no misidentifications. Also red snapper have always been kept separate from the unclassified snappers because of their value. If any unclassified snappers were actually red snapper then it was insignificant. Data supporting this is anecdotal.

#### 3.3.1.1 Decision 3.

The Workgroup concurs with prior SEDAR 15 decision that concerns about mis-identification and unclassified snappers are not significant, and no adjustments are needed. This decision was approved by the plenary.

### 3.3.2 Historical Commercial Landings

Next, historical landings of red snapper for 1902-1989 were obtained from Fisheries Statistics Division (1990). These landings, without any attempt at interpolation, are provided for 1927-1949 (Table 3.1) to provide insight into historical red snapper landings prior to the beginning of data provided by ACCSP and NMFS ALS data bases (1950 to present). Commercial landings by state are summarized in Figure 3.3 for the full time series provided in this document (1902-1989).

From Red Grouper SEDAR 19:

“The annual data on commercial landings begins in 1950, while previous to that year, data collection was inconsistent, but collected by federal agencies starting 1880. Prior to 1950, there may be gaps of up to 10 years between the collection of landings statistics in some states and even these years may not be complete. The use of interpolation to fill in years where data were not collected has been discouraged because of the annual variations in landings, which could lead to erroneous or misleading estimates (Chestnut & Davis, 1975).”

#### 3.3.2.1 Decision 4.

Because available red snapper landings for 1927-1949 were significant, but with some missing years of data, the Workgroup concluded that it was still useful to report these earlier red snapper landings for better understanding the potential magnitude during this earlier period. Historical commercial landings data prior to 1927 are too sparse and difficult to interpret.

The Commercial Workgroup discussed and agreed to this decision. For SEDAR 24, Commercial Workgroup suggests only presenting landings prior to 1950 because uncertainty in these data is high. A caveat should be included that some of these landings were driven by incomplete data collection, with NMFS collecting data more consistently beginning in 1950, therefore, increases in the data could be due to increased data collection. After 1950, there is more consistency in the data and the WG has greater confidence in these data. The Workgroup suggests some consideration of sensitivity runs to determine the impact of the data from years prior to 1950. This decision was approved by the plenary.

### 3.3.3 Development of Commercial Landings by Gear and State

Historical commercial landings (1950 to present) for the Atlantic coast are maintained in the Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse. The Data Warehouse is on-line data base of fisheries dependent data provided by the ACCSP partners. Data sources and collection methods are illustrated by state in Figure 3.4. The Data Warehouse was queried in May 2010 for all red snapper landings (annual summaries by state and gear category) from 1950 to present for Florida (east coast), Georgia, South Carolina, North Carolina, Virginia, Maryland, New Jersey, New York, Connecticut, Rhode Island, New Hampshire and Maine (ACCSP, 2010). Data are presented using the gear categories as determined at the workshop. The specific ACCSP gears in each category are listed in Table 3.2. Commercial landings in pounds (whole weight) were developed based on classified red snapper by the Working Group from each state as available by gear for 1950-2009.

Historically, conversions between whole and gutted weight have been based on state specific values. The standard conversion of snappers for Georgia and Florida from gutted weight to whole weight is by multiplying gutted weight by 1.11. South Carolina uses a conversion of about 1.075, obtained by dividing gutted weight by 0.93. North Carolina uses a conversion multiplier of 1.08. During SEDAR 15, conversions from gutted back to whole weight were based on data from the South Carolina MARMAP program. Although the sample size was still somewhat small (N=30) the $R^2$ value was high (0.9996) with no value having high leverage. The no-intercept regression estimate for slope is 1.076 (the ratio of means for whole weight to gutted weight) (see **Table 2.10.1** in Section 2).

Concern was raised about the possibility of double counting; i.e., inclusion of recreationally-caught fish in the commercial landings. The consensus of the Workgroup was that this was not significant issue. Furthermore, there are no means for identifying recreationally caught fish in the commercial data bases. Selling of recreationally-caught red snappers without a commercial snapper-grouper permit has recently been banned (Amendment 15B).

#### 3.3.3.1 Florida

Prior to 1986, Florida commercial landings data were collected through the NMFS General Canvass via monthly dealer reports. In 1984, the state of Florida instituted a mandatory trip level reporting program to report harvest of commercial marine fisheries products in Florida via a marine fisheries trip ticket. The program requires seafood dealers to report all transactions of marine fisheries products purchased from commercial fishers, and to interview fishers for pertinent effort data. Trip tickets are required to be received monthly, or weekly for federally managed species. Data reported on trip tickets include participant identifiers, dates of activity, effort and location data, gear used, and composition and disposition of catch. The program encompasses commercial fishery activity in waters of the Gulf of Mexico and South Atlantic from the Alabama-Florida line to the Florida-Georgia line. The first full year of available data from Florida trip tickets is 1986.

A data set was provided to the commercial workgroup of summarized red snapper landings by year, area fished, county landed, and gear with whole pounds and number of trips from Florida South Atlantic waters. The data set also includes associated species groups from all snapper trips. Gear categories include hook & line, long line, diving, trap, trawl and other/unknown. NMFS logbook data will be used to further define Florida landings from South Atlantic waters. Comparisons were made between Florida trip ticket data and NMFS ALS, and because they showed very little difference, the Workgroup agreed to use the ALS data as modified for Monroe County for Florida commercial landings for 1962-2009. Landings from the ACCSP data base were selected for 1950-1961.

#### 3.3.3.2 Georgia

GA DNR provided landings by gear back to 1989 (state reported landings were almost identical to ALS landings), and the landings maintained in the ACCSP data base were selected for 1950-2009.

#### 3.3.3.3 South Carolina

The landings data for South Carolina comes from two different sources. The first, 1980-2003, is from the old NMFS Canvass data system. This system involved wholesale seafood dealers reporting total monthly landings by species to the state. The second, 2004-present, is the ACCSP Trip Ticket System. This requires wholesale seafood dealers to fill out an individual Trip Ticket for each trip that each commercial Snapper Grouper boat makes. The landings are broken down by species, gear type, and area fished. The landings maintained in the ACCSP data base were selected for 1950-2009.

#### 3.3.3.4 North Carolina

Prior to 1978, the National Marine Fisheries Service collected commercial landings data for North Carolina. Port agents would conduct monthly surveys of the state's major commercial seafood dealers to determine the commercial landings for the state. Starting in 1978, the North Carolina Division of Marine Fisheries entered into a cooperative program with the National Marine Fisheries Service to maintain the monthly surveys of North Carolina's major commercial seafood dealers and to obtain data from more dealers.

The North Carolina Division of Marine Fisheries Trip Ticket Program (NCTTP) began on 1 January 1994. The NCTTP was initiated due to a decrease in cooperation in reporting under the voluntary NMFS/North Carolina Cooperative Statistics Program in place prior to 1994, as well as an increase in demand for complete and accurate trip-level commercial harvest statistics by fisheries managers. The detailed data obtained through the NCTTP allows for the calculation of effort (i.e. trips, licenses, participants, vessels) in a given fishery that was not available prior to 1994 and provides a much more detailed record of North Carolina's seafood harvest.

Three datasets were provided to the commercial group for the SEDAR 24 Data Workshop. North Carolina commercial landings of red snapper were provided for 1950-2009 by year and gear type. Gears were grouped into the following categories: Handlines, Longlines, Pots, Trawls, Spears, and Others[1]. Commercial landings for red snapper from the NC trip ticket

[1] SAS code used to group trip ticket gears into these categories:

```
If Gear1 in (210,215) Then Delete;
If Gear1=480 and Gear2=610 and Gear3=. Then Gear1=610;
If Gear1=676 and Gear2=660 and Gear3=. Then Gear1=610;
If Gear1=677 and Gear2=610 and Gear3=. Then Gear1=610;
Length Geartype $ 15;
If (200 LE GEAR1 LE 220) Then Geartype='Trawls';
Else if (320 LE GEAR1 LE 390) Then Geartype='Pots';
Else if (600 LE GEAR1 LE 616) Or Gear1 in (660,665) Then Geartype='Handlines';
Else if Gear in (675,676,677) then Geartype='Longlines';
Else if Gear1 in (760,943) Then Geartype='Spears';
Else Geartype='Others';
```

program were also provided by month and market grade for only handlines and spears from 1994-2009. These landings were selected for use in this assessment.

#### 3.3.3.5 Combined State Results

The decision of the Commercial workgroup was to use landings data provided by the ACCSP for Georgia and South Carolina for all years (1950-2009) and data from 1950 – 1961 from all states (including Florida and North Carolina). The Workgroup used landings data from NC DMF for 1962-2009. Finally, Florida landings from 1962-2009 were based on ALS data base as modified above for Monroe County (logbook was used for proportions from 1992-2009).

Landings are presented in Table 3.3 and Figure 3.5. Note that landings for the states of Georgia through North Carolina are combined for confidential reasons in Table 3.3. Since 1950, Florida produced 83% of the commercial harvest, Georgia 4.3%, South Carolina 7.1%, and North Carolina 5.6%. Since 1984 when diving appeared in the data set, handlines have represented about 95.4% of the catch compared with 4.6% for diving (Table 3.4 and Figure 3.6). Diving has risen to as high as 13% of the total commercial landings in some years. Trivial amount of landings by other gears have been pooled with the handline gear, including longline (0.8%), traps (0.6%), trawls (0.6%), and other (1.6%, mostly combined or mixed gears).

### 3.3.4 Decisions Related To Commercial Landings by Gear and State

#### 3.3.4.1 Decision 5.

The Workgroup recommends that landings by fishing gear be reduced to two categories, the dominant handline gear and diving/spear gear. The small percentage from miscellaneous other gears (e.g., longline, trawls and traps) should be pooled with handlines.

The Commercial Workgroup makes this recommendation largely because of the small amount of other miscellaneous gears. The Workgroup notes that discard data from the snapper-grouper logbook (2002-2009) showed that only handline gears reported discards. Separating handline and diving gears is done because there are differences in the discard mortality and there may be differences in the selectivity and, therefore, length data between the two gears. Diving gear typically would catch larger red snapper on average. This decision was approved by the plenary.

#### 3.3.4.2 Decision 6.

The Workgroup made the following decisions for reporting of commercial landings:

- Landings should be reported as whole weight (rather than gutted)
- Landings by state should be separated into Florida (South Atlantic) and Georgia-North Carolina to maintain confidentiality for Georgia landings.
- Discussion concerning development of GIS maps of effort from logbook data set.

**Whole vs Gutted Weight** – The Commercial Workgroup discussed the topic of what units to use to report commercial landings. Although landings were reported in gutted weight in SEDAR 15, it was agreed to report them in whole weight in this report. Red snapper are typically landed gutted and converted by the states to whole weight. For this analysis, states provided their landings in gutted weight or if in whole weight, were converted back to gutted weight using the state specific conversion given earlier. Once the state landings were all in gutted weight, they were all converted to whole weight using the whole weight-gutted weight conversion developed from MARMAP data (see Life History Workgroup, Section 2). Early landings data for 1950-1961 were received in whole weight from ACCSP and no modifications were made to these.

This decision was approved by the plenary.

**Confidentiality Issues** – The Commercial Workgroup agreed to pool Georgia commercial landings with one or more of the other states because of confidentiality issues. The Workgroup recommended that Georgia landings be pooled with South and North Carolina (the rule of "3") as the simplest approach. Also, Florida landings went through additional processing for splitting out Monroe County described during Decision 2.

This decision was approved by the plenary.

**GIS Maps** – The Commercial Workgroup discussed an addition embedded within this ToR (*Provide maps of fishery effort and harvest*) and determined that it would be possible to develop maps of effort and catch from logbook data, but the plot could pose confidentiality issues. A table of trips and catch organized by latitude and longitude (in reverse numeric order to line up with the coast) was created in Excel by color coding trip and landings summed across years 1993-2009 (Figure 3.7). Only latitude/longitude combinations that had less than 10 trips or 100 lbs for the time period was dropped from the analysis.

In addition, a bathymetric map of the South Atlantic coastline was provided (Figure 3.8). Depth zones are highlighted in this figure. The zone in yellow represents depths from 30 m to 60 m (98 – 197 ft), and the zone in red represents depths from 60 m to 80 m (197 – 263 ft). The yellow zone includes the depths where most red snapper are caught by handline according to the logbook data (2004-2009).

A recommendation was approved by the plenary to seek GIS help to overlay these latitude/ longitude data onto a geographic map, and develop a bathymetric map of the U.S. South Atlantic coast. This task was completed after the workshop.

### 3.3.5 Converting Landings in Weight to Landings in Numbers

Commercial landings in weight were converted to commercial landings in numbers based on average weight (in pounds whole weight) from the TIP data for each state, gear, and year. These data were generally available from 1984 to 2009 for handlines (19,251 lengths). Data for the remaining gear types were sparse, with much more limited data from diving (502), longlines (165), traps (284), and trawls (289), and other (2) gear types available (annual sample sizes by gear, state and year are summarized in Table 3.5). Annual estimates of mean weight by gear, state and year are applied to the corresponding landings in weight when sample size greater than or equal to 20 were available (Table 3.6). When sample size did not meet this criterion, then averages across state and years for each gear were used. Because of a change in minimum size limits in 1992, mean weights calculated before 1992 were applied to years prior to 1992, and means for 1992 and later were applied for years 1992 and later. Red snapper landings in numbers are summarized by gear in Table 3.7 and in Figure 3.9.

Commercial Workgroup discussed uncertainty for landings by year and state and reported that increased uncertainty should be noted as one goes back in time (Table 3.8). CVs were developed from expert opinion recognizing these time breaks that reflect improvements in data collection methodologies leading to smaller CVs over time. Between 1950 and 1961, there was consistent reporting of commercial landings (CV = 50%). The ALS system began in 1962 (first reduction in uncertainty to 40%). Georgia, South Carolina and North Carolina began collecting data under the Cooperative Statistics Program in 1981, while Florida began its Trip Ticket Program in 1986 (fully instituted). CV was reduced to 20% following these actions. North Carolina introduced their Trip Ticket Program in 1994, Georgia in 2002, and South Carolina in 2004; while Florida's Trip Ticket Program was adopted by the ALS in 1997. CV was lowered to 10% with these dates. The information summarized in Table 3.9 parallel that used in SEDAR 20 for red grouper. This approach was recommended by the Commercial Workgroup.

## 3.4 Commercial Discards

### 3.4.1 Commercial Discard Estimates from Logbook

Commercial discards were calculated for vertical line (handline and electric reel) vessels in the US South Atlantic using methods described in SEDAR 24-DW01. Other gears reported fewer than 10 trips (per gear) with red snapper discards during the period 2002-2009. Longline vessels (162 trips reporting some discards) never reported red snapper discards to the discard logbook program, however, underreporting of discards may have occurred given that more than 250 longline trips reported no discards of any species.

Two methods were used to calculate total discards. A continuity approach followed the methods of SEDAR 15 and included a bootstrap resampling procedure to estimate possible variability in the discard estimate. An alternative method using delta-lognormal model generated least squares means of year-specific discard rate was also used to calculate total yearly discards for the period 2002-2009 (when discard data were reported). Discard rate for the period 1992-2001 (prior to discard reporting) was assumed to be the mean discard rate over the years 2002-2009, weighted by sample size. Both methods used calculated discard rates along with vertical line effort reported to the coastal logbook program as ratio estimators of total discards. Discards were reported in numbers of red snapper.

The working group recommended using the delta-lognormal method of calculating discard rates. Data included in that calculation were filtered to remove records from fishers who reported "no discards" of any species for 75% or more of reported trips during years with four or more trips reported by the fisher. This data filter was necessary due to consistent nonreporting of discards by some fishers. Including effort from those fishers would have resulted in discard rates that were erroneously low. The working group also recommended using the data filtering methods used in SEDAR 15 when summing total effort. More restrictive data filters were rejected by the group as likely to result in an under estimate of total discards. The working group noted that no regulatory changes occurred during the period 1992-2009 that would have affected red snapper discard rate. The working group, therefore, accepted the method of using the 2002-2009 weighted mean discard rate for calculating 1992-2001 discards.

Total discards, calculated using SEDAR 15 methods (continuity case), bootstrapped estimates, the 2010 delta-lognormal method, and the SEDAR 15 calculated discards, are included in Table 3.9.

#### 3.4.1.1 Decision 7a.

The Workgroup accepts the discard estimates of red snapper for 1992-2009 as developed in S24DW01.

The commercial working group accepted the methods of SEDAR24-DW01 for calculating commercial vertical line vessel red snapper discards for the years 1992-2009. Fewer than 10 trips by any other gear reported red snapper discards, suggesting that discards from other commercial gears was minimal. The specific method chosen by the working group was the use of a delta-lognormal model to calculate year-specific least squares means of red snapper discard rate. Those discard rates were used with yearly total vertical line effort reported to the coastal logbook program as a ratio estimator of total discards. The working group also endorsed using the mean discard rate over the years 2002-2009, weighted by sample size, as the discard rate for the period 1992-2001 (prior to discard reporting). No effort data were available for calculating discards prior to 1992 and the working grouper recognized that changes in minimum size regulations in 1991 would have made such calculations unreliable.

The discard calculations rely on self-reported discard and effort data. Perhaps the most important source of error in the commercial discard calculations was misreporting and non-reporting of discards, both of red snapper and other species. An effort was made to minimize that potential error by filtered the discard data to remove records from fishers who reported "no discards" of any species for 75% or more of reported trips during years with four or more trips reported by the fisher. Including effort from those fishers would have resulted in discard rates that were erroneously low. Although such clear instances of discard non-reporting were identified and excluded, other cases of non-reporting and misreporting have not been quantified. The degree to which this may have affected the discard calculations is unknown.

Actual red snapper discards may be higher than the calculated totals presented in SEDAR 24-DW01. In the limited observer data available discarded red snapper were more common than retained red snapper (60% to 40% of 644 fish). Self-reported discards were reported in numbers of fish and lack length information making a similar comparison with landings data difficult. Discards and landings of red snapper from the commercial fishery, however, appear to be relatively low, particularly when compared to the recreational fishery. The total commercial discards from SEDAR 24-DW01 may represent a minimum estimate of the number of red snapper discarded from the commercial fishery. The conclusion of the commercial working group was that SEDAR 24-DW01 represents the best available information on commercial red snapper discards.

This decision was approved by the plenary.

### 3.4.2 Discard Length Frequency

Observer discard data were made available during the Data Workshop to the Commercial Workgroup. Procedures relevant to the collection of these data are reported in GSAFF (2008). These data were collected from vertical line gear (handline) between latitudes 30 and 33 (Table 3.10) during 2007-2009. An un-weighted length composition was developed from these data (Figure 3.10) and added to the Excel Input Data File. The average weight of these fish was 2.9 pounds.

### 3.4.3 Discard Mortality Estimates

The work reported in this subsection falls under **Terms of Reference #5**. The plenary decided to develop discard mortality estimates based on the relationship of discard mortality with depth (Burns et al. 2004). Given this decision by the plenary, the Commercial Workgroup considered two approaches for estimating overall discard mortality from the commercial handline gear based on available depth information. One method considered logbook depth profile information relative to catch (not discard). The second method, used observer data having depth information for released fish (GSAFF 2008). These observer data were collected during 2007-2009 between latitudes 30 and 33. Estimates of mortality were obtained by calculating a weighted average of mortality from the Burns et al. equation, weighted by depth profile. The profiles were computed in 25 ft intervals while the mortality estimates from Burns et al. (2004) were computed at the mid-points of these intervals. These estimates were relatively insensitive to interval width since approximately the same result (same whole percent) was obtained with 1 ft intervals from the observer data. Computed values by depth interval are summarized in Table 3.11, while these values are plotted in Figure 3.11.

For representing discard mortality of red snapper discarded from 1992-2009, the WG recommended the mortality estimate based on discard fish (48%).

#### 3.4.3.1 Decision 7b

The Workgroup also recommended using observed discard information with depth to estimate commercial handline discard mortality (48%).

This decision was approved by the plenary.

## 3.5 Biological Sampling

Length frequency data were extracted from the TIP Online data base. Data from the VA/NC line through Monroe County in FL were included in the extraction. Those data from Monroe County that were attributable to the Gulf were deleted from the data. All lengths were converted to TL in mm using conversions derived from the Life History Group. We had no conversions for standard length, so these were deleted. Lengths greater than 2,000 mm (2 m) were deleted, as the group felt that these extreme lengths may be errors and did not represent those lengths observed in the commercial fishery. Lengths were converted to cm and assigned to 1 cm length bins with a floor of 0.5 cm and a ceiling of 0.4 cm. Weights were converted to whole weight in grams using the length/weight relationship supplied by the Life History Group and then converted to whole weight in pounds. Mean weights were then calculated across year, state and gear.

### 3.5.1 Sampling Intensity for Lengths

Annual sample sizes are summarized in Table 3.5 by gear, state, and year for length data available for red snapper in the U.S. South Atlantic from the TIP data base for 1984-2009.

### 3.5.2 Length/Age Distribution

Annual length compositions were created for each commercial gear using the following approach for weighting lengths across individual trips and by state:

- Trips: expand lengths by trip catch in numbers,

- State: expand lengths by landings in numbers.

Annual length compositions for commercial handlines are shown weighted by the product of the landings in numbers and trip catch in numbers (for 1985-1986, 1988-2004, 2007, and 2009 in Figure 3.12). Annual length compositions for commercial diving (for 1999-2001, 2003, and 2009 in Figure 3.13), are also summarized using weighting by landings in numbers and by trip catch in numbers.

Sample size of red snapper ages are summarized by gear from commercial landings in the U.S. South Atlantic for 1984-2009 (Table 3.12). Age compositions were developed for handline (1992-2009 with exceptions in Figure 3.14) and diving (2000-2009, Figure 3.15) gear types. Weighting is by length compositions shown in Figures 3.12 and 3.13, respectively. This corrects for a potential sampling bias of age samples relative to length samples (see Section 3 in SEDAR10 for South Atlantic gag).

### 3.5.3 Adequacy for characterizing lengths

Generally sample sizes for length composition may be adequate for the handline component of the commercial fishery (Table 3.5). Overall 19,251 fish lengths were collected from handlines during1984-2009. However, no lengths were collected from Florida in 1984 and 1987. Less than 10 fish were collected from Florida in 1988, 2005-2006, and 2008. Useful length compositions are generally available for handlines for 1985-1986, 1989-2004, 2007, and 2009.

Much more limited length compositions are available for diving (502 lengths), longlines (167 lengths), traps (284 lengths), and trawls (289 lengths) for the period 1984-2009. Potentially useful length compositions would be available from diving for 1999-2003 (except 2002), from longlines for 1987 (NC only), from traps for 1991 (almost all from SC), and from trawls for 1984, 1986-1988 (principally from SC). With such limited length compositions from longlines, traps and trawls, the small amount of samples from these gears should be pooled with others and then incorporated with handlines per **Decision 6**.

Annual length compositions were developed for handline and diving gear types. Handline length compositions should be applied to ‘other’ gear types to represent length compositions.

#### 3.5.3.1 Decision 8.

The Workgroup reviewed the adequacy of biological sampling regime (TIP):

- Rules were recommended that define minimum length and age composition data based on sample sizes and geographic coverage and recommended to the plenary.
- Market categories were found to be too limited in their availability for use in post-stratifying TIP length data.

<u>Sampling Adequacy for Lengths</u>: Sample size of length data available from TIP are summarized in Table 3.5. For handline samples sizes, the Commercial Workgroup agreed that at least 20 lengths were required from Florida for an annual length or age composition to be developed for that year. Since 1984, data were insufficient for 1984, 1987-1988, 2005-2006, and 2008. For diving gear, the group agreed that at least 20 fish overall were needed to develop length compositions. Adequate samples sizes were available for 1999-2003, excluding 2002.

Mean weights were calculated by state, gear, year from the TIP length samples where sample sizes were sufficient (Table 3.6). These mean weights were used to convert landings in weight to landings in numbers as described in Section 3.2.4. As noted earlier, prior to 1992 and after 1992 were treated separately because of the increase in size limit for red snapper from 12 to 20 inches that occurred in 1992.

Sampling Adequacy for Ages: Red snapper age data from commercial gears were provided by the life history group and presented to the Commercial Workgroup (Table 3.12). The Workgroup recommended that at least 10 fish be the minimum requirement for use in developing age compositions. The Workgroup further stipulated that at least 10 aged fish from Florida handline be required. No samples were available from Florida until 1992. In addition, 1993 and 1994 for handlines were dropped, because only 7 and 1 fish, respectively, were available from Florida. Otherwise samples sizes generally exceed 50 from Florida between 1996 and 2009. Only four years of age data from diving gear were available: 2000, 2001, 2007, and 2009. Year 2007 was dropped due to low sample size.

Market Category: The topic of whether to use market category to post-stratify length data has been raised in past SEDARs. Unfortunately, both ALS landings and TIP length samples having market category other than unsorted were extremely limited (Figure 3.16). Years 2006-2009 from ALS landings data was generally greater than or equal to 90% unsorted. Length samples between 1984 and 2009 from TIP were all above 65% unsorted and almost all 100% unsorted especially in most recent years from 1996 to 2009. As a result, the Commercial Workgroup decided that sampling was not adequate to post stratify by market grade.

The decisions above were approved by the plenary.

## 3.6 Relative selectivity for commercial gears

Data Workshop Term of Reference #9: Review SEDAR 15 and SEDAR 7 approaches to selectivity of red snapper, post-SEDAR 15 evaluations of fishery selectivity patterns for Atlantic red snapper, and available length and age composition information to develop recommendations for addressing fishery selectivity in the assessment model. Specifically address the degree to which domed shape selectivity should be applied to hook and line fisheries.

### 3.6.1 Statement from Commercial Fishermen

Rationalize why the older red snapper, which are usually larger, are not being caught by the commercial fisherman in the South Atlantic.

First of all the older red snapper have been observed moving offshore into deeper water as they grow. Also, older Red Snapper become less gregarious and live a more solitary life.

The older red snapper are not being harvested by the divers due to their limited depth to spear. Most divers dive in 120 ft of water and shallower which would limit their ability to even interact with the older deep water red snapper.

The long liners have been historically known to catch the older red snapper (SEDAR - GoM). In 1992 the long liners were forced to fish in 300 ft of water and deeper; this limited their chance of interacting with red snapper. They were not allowed to possess any shallow water species. These regulations would eliminate any records of red snapper landing by the long liners.

As for the commercial fisherman that specifically target red snapper, their techniques have changed through the years. The fisherman are now utilizing rod and reels instead of the traditionally used bandit gear. They use lighter mono to generated more bites and be more productive. The fisherman is targeting large schools of 5 to 10 pound fish which are favored more by the fish markets. Although when a large 20 to 30 pound red snapper is hooked, the lighter tackle is less likely to land the fish (FL fisherman attendee's demonstration).

As for the fisherman who use bandit gear and catch red snapper, they too have switched to smaller mono to get more bites. This would also limit their ability to land older red snapper. My experience is that most of the large red snapper hooked act considerably like a shark on bandit gear. So sometimes landing the suspected shark is not so important and most likely to break off the gear (Ken Fex, AP member, NC fisherman).

The bandit gear is also limited by stronger current in the deeper depth. Anchoring in the Gulf Stream currents is sometimes too challenging and risky to gear. The ability to anchor the vessel to get the baited hooks to the fish that might be several yards behind the boat. Also bottom structure like ledges, pinnacles, and steeples limit anchoring ability (workshop comment by Rusty Hudson).

So in conclusion, the fishermen believe that older red snapper are not being landed due to evolving fishing techniques, market demand, depth, and regulations restricting long liners.

### 3.6.2 Preliminary Logbook Discussions

Include discussion of longline landings on Atlantic, comparison of effort between handlines and longlines by depth.

A preliminary consideration of depth, effort and landings data available from logbooks was presented to the Commercial Workgroup. Depth started being recorded on logbooks in 2004 so comparisons were for the years of 2004-2009 combined. Handlines and longlines were broken out and analyzed further because handlines are the dominant gear in the SA for red snapper and longlines were included because it is an important gear in the GOM for red snapper. The trips with depth for red snapper were compared for a variety of other species (red snapper, scamp, snowy grouper, speckled hind, tilefish, vermilion snapper, and yellowedge grouper). A comparison was also made between areas (SA, GA-FL, and GoM) by depth for all gears. These depth profiles were plotted and presented to the group before being presented to plenary.

Observer data was considered as an alternate data set for more detailed study concerning depth information, but does not include other gears besides handline and has very limited number of observations (and trips). The Commercial Workgroup agreed that, in general, the logbook is the best data on depth available because the observer data does not have any other gears besides handline and has limited amount of trips and observations.

A working paper exploring the logbook data base will be prepared for the assessment workshop including the caveats of the logbook data discussed during the Workgroup meetings.

#### 3.6.2.1 Decision 9.

The Commercial Workgroup agreed that, in general, the logbook is the best data on depth available for analyses investigating landings and effort by depth.

This decision was approved by the plenary.

Landings of red snapper from the longline gear have never been large, certainly not compared to the handline gear (Table 3.13). Note that the SAFMC in Snapper Grouper Amendment 4, prohibited use of longline gear inside 50 fathoms (300 ft) in 1992. In 1999, they prohibited vessels with longline gear aboard from possession of red snapper with Snapper Grouper Amendment 9.

Sampling of red snapper for lengths from longline gear has been equally infrequent (Table 3.14). Sample sizes suggest that the only valid comparison between handline and longline that might be conducted would be limited to the North Carolina samples in 1987. In 1987, there were 81 fish collected in North Carolina longline and a corresponding 277 fish collected from handline. A plot of the cumulative proportion with increasing length suggests that longline catch larger fish than handline (Figure 3.17). This should be expected since most (not all) handline gear is found in shallower water than longline gear. The Commercial Workgroup considered the limited nature of these data, and suggested that they are probably insufficient to settle the issue of whether the selectivity of handline gear is more dome-shaped than the presumed flat-topped shape for longline gear. The limited nature of these data and small sample sizes for longlines are too low to determine selectivity.

## 3.7 Itemized list of tasks for completion following workshop

See Section 1.5

## 3.8 Literature Cited

Atlantic Coastal Cooperative Statistics Program. 2010. (1950-2009) Annual landings by state and custom gear category; generated by Julie Defilippi; using ACCSP Data Warehouse, Washington, D.C: accessed May, 2010.

Burns, Karen M, Nicholas F. Parnell, Raymond R. Wilson. 2004. Partitioning release mortality in the undersized red snapper bycatch: Comparison of depth vs. hooking effects. MARFIN Grant No. NA97FF0349, Mote Marine Laboratory Tech. Rep. No. 932, Sarasota, FL.

Fisheries Statistics Division. 1990. Historical Catch Statistics, Atlantic and Gulf Coast States, 1879-1989. Current Fishery Statistics No. 9010, Historical Series Nos. 5-9 Revised. (NTIS No. PB-93-174274)

Gulf and South Atlantic Fisheries Foundation (GSAFF). 2008. Catch characterization and discard within the snapper grouper vertical hook-and-line fishery of the South Atlantic United States. Final Report, Gulf and South Atlantic Fisheries Foundation, 5401 W. Kennedy Blvd, Suite 740, Tamp, Florida 33609-2447 (SEDAR24-RD61).

## 3.9 Tables

**Table 3.1.** Historical red snapper landings (pounds, whole weight) by state from 1927-1949. (Source: Fisheries Statistics Division. 1990. *Historical Catch Statistics, Atlantic and Gulf Coast States, 1879-1989*, US DOC/NOAA/NMFS, Current Fishery Statistics No. 9010, Historical Series Nos. 5-9).

| Year | NC | SC | GA | FL(E) | Total |
|---|---|---|---|---|---|
| 1927 | 1,000 | | 64,000 | 59,000 | 124,000 |
| 1928 | 2,000 | | 22,000 | 47,000 | 71,000 |
| 1929 | 15,000 | | 33,000 | 19,000 | 67,000 |
| 1930 | 5,000 | | 30,000 | 34,000 | 69,000 |
| 1931 | 2,000 | | | 112,000 | 114,000 |
| 1932 | | | | 49,000 | 49,000 |
| 1933 | | | | | |
| 1934 | | | | 152,000 | 152,000 |
| 1935 | | | | | |
| 1936 | | | | 140,000 | 140,000 |
| 1937 | | | | 210,000 | 210,000 |
| 1938 | 1,000 | | | 117,000 | 118,000 |
| 1939 | 2,000 | | | 96,000 | 98,000 |
| 1940 | | | | 14,000 | 14,000 |
| 1941 | | | | | |
| 1942 | | | | | |
| 1943 | | | | | |
| 1944 | | | | | |
| 1945 | 4,000 | | | 246,000 | 250,000 |
| 1946 | | | | | |
| 1947 | | | | | |
| 1948 | | | | | |
| 1949 | | | | | |

**Table 3.2.** Specific ACCSP gears in each gear category for red snapper commercial landings.

| ACCSP_GEAR_CODE | ACCSP_GEAR_NAME | ACCSP_TYPE_NAME | SEDAR24_CATEGORY |
|---|---|---|---|
| 000 | NOT CODED | NOT CODED | OTHER GEARS |
| 010 | HAUL SEINES | HAUL SEINES | OTHER GEARS |
| 020 | OTHER SEINES | HAUL SEINES | OTHER GEARS |
| 050 | POUND NETS | FIXED NETS | OTHER GEARS |
| 073 | FLOATING TRAPS (SHALLOW) | FIXED NETS | POTS AND TRAPS |
| 091 | OTTER TRAWL BOTTOM, CRAB | TRAWLS | TRAWLS |
| 092 | OTTER TRAWL BOTTOM, FISH | TRAWLS | TRAWLS |
| 093 | OTTER TRAWL BOTTOM, LOBSTER | TRAWLS | TRAWLS |
| 095 | OTTER TRAWL BOTTOM, SHRIMP | TRAWLS | TRAWLS |
| 110 | OTHER TRAWLS | TRAWLS | TRAWLS |
| 118 | BUTTERFLY NETS | TRAWLS | OTHER GEARS |
| 130 | POTS AND TRAPS | POTS AND TRAPS | POTS AND TRAPS |
| 132 | POTS AND TRAPS, BLUE CRAB | POTS AND TRAPS | POTS AND TRAPS |
| 139 | POTS AND TRAPS, FISH | POTS AND TRAPS | POTS AND TRAPS |
| 140 | POTS AND TRAPS, SPINY LOBSTER | POTS AND TRAPS | POTS AND TRAPS |
| 200 | GILL NETS | GILL NETS | OTHER GEARS |
| 201 | GILL NETS, FLOATING DRIFT | GILL NETS | OTHER GEARS |
| 204 | GILL NETS, SINK ANCHOR | GILL NETS | OTHER GEARS |
| 205 | GILL NETS, RUNAROUND | GILL NETS | OTHER GEARS |
| 300 | HOOK AND LINE | HOOK AND LINE | HAND LINE |
| 301 | HOOK AND LINE, MANUAL | HOOK AND LINE | HAND LINE |
| 302 | HOOK AND LINE, ELECTRIC | HOOK AND LINE | HAND LINE |
| 303 | ELECTRIC/HYDRAULIC, BANDIT REELS | HOOK AND LINE | HAND LINE |
| 320 | TROLL LINES | HOOK AND LINE | HAND LINE |
| 400 | LONG LINES | LONG LINES | LONG LINES |
| 401 | LONG LINES, VERTICAL | LONG LINES | LONG LINES |
| 402 | LONG LINES, SURFACE | LONG LINES | LONG LINES |
| 403 | LONG LINES, BOTTOM | LONG LINES | LONG LINES |
| 404 | LONG LINES, SURFACE, MIDWATER | LONG LINES | LONG LINES |
| 550 | DIP NETS | DIP NETS AND CAST NETS | OTHER GEARS |
| 551 | CAST NETS | DIP NETS AND CAST NETS | OTHER GEARS |
| 600 | TONGS | RAKES, HOES, AND TONGS | OTHER GEARS |
| 660 | SPEARS | SPEARS AND GIGS | DIVING |
| 661 | SPEARS, DIVING | SPEARS AND GIGS | DIVING |
| 700 | HAND LINE | HAND LINE | HAND LINE |
| 701 | TROLL AND HAND LINES CMB | HAND LINE | HAND LINE |
| 750 | BY HAND, DIVING GEAR | BY HAND | DIVING |
| 760 | BY HAND, NO DIVING GEAR | BY HAND | OTHER GEARS |
| 800 | OTHER GEARS | OTHER GEARS | OTHER GEARS |
| 801 | UNSPECIFIED GEAR | OTHER GEARS | OTHER GEARS |
| 802 | COMBINED GEARS | OTHER GEARS | OTHER GEARS |
| 804 | CHEMICAL, OTHER | OTHER GEARS | OTHER GEARS |

**Table 3.3.** Red snapper landings (pounds whole weight) by region from the U.S. South Atlantic, 1950-2009.

| Year | Florida | GA-NC | Total |
|---|---|---|---|
| 1950 | 358,200 | 0 | 358,200 |
| 1951 | 510,100 | 7,500 | 517,600 |
| 1952 | 384,300 | 5,000 | 389,300 |
| 1953 | 401,900 | 0 | 401,900 |
| 1954 | 595,600 | 3,000 | 598,600 |
| 1955 | 497,800 | 0 | 497,800 |
| 1956 | 341,900 | 142,400 | 484,300 |
| 1957 | 642,900 | 226,000 | 868,900 |
| 1958 | 589,400 | 27,900 | 617,300 |
| 1959 | 629,100 | 33,600 | 662,700 |
| 1960 | 666,900 | 10,200 | 677,100 |
| 1961 | 678,200 | 121,600 | 799,800 |
| 1962 | 652,500 | 10,046 | 662,546 |
| 1963 | 500,700 | 4,139 | 504,839 |
| 1964 | 550,400 | 9,056 | 559,456 |
| 1965 | 640,500 | 16,226 | 656,726 |
| 1966 | 729,200 | 10,857 | 740,057 |
| 1967 | 903,500 | 60,192 | 963,692 |
| 1968 | 973,200 | 95,970 | 1,069,170 |
| 1969 | 670,900 | 29,523 | 700,423 |
| 1970 | 613,600 | 27,266 | 640,866 |
| 1971 | 482,900 | 60,499 | 543,399 |
| 1972 | 402,400 | 66,135 | 468,535 |
| 1973 | 350,800 | 36,470 | 387,270 |
| 1974 | 578,200 | 54,250 | 632,450 |
| 1975 | 710,000 | 35,339 | 745,339 |
| 1976 | 526,100 | 92,742 | 618,842 |
| 1977 | 504,906 | 144,038 | 648,943 |
| 1978 | 374,454 | 215,046 | 589,500 |
| 1979 | 247,289 | 162,433 | 409,723 |
| 1980 | 231,071 | 149,283 | 380,355 |
| 1981 | 198,893 | 172,248 | 371,140 |

**Table 3.3 continued**

| | | | |
|---|---|---|---|
| 1982 | 160,617 | 145,251 | 305,868 |
| 1983 | 168,216 | 141,777 | 309,993 |
| 1984 | 141,946 | 107,320 | 249,266 |
| 1985 | 152,896 | 90,453 | 243,349 |
| 1986 | 134,200 | 81,942 | 216,143 |
| 1987 | 125,358 | 61,748 | 187,106 |
| 1988 | 100,566 | 63,389 | 163,954 |
| 1989 | 116,793 | 141,330 | 258,123 |
| 1990 | 106,372 | 110,245 | 216,617 |
| 1991 | 74,082 | 65,685 | 139,767 |
| 1992 | 57,967 | 40,611 | 98,578 |
| 1993 | 59,518 | 135,739 | 195,257 |
| 1994 | 80,290 | 112,189 | 192,479 |
| 1995 | 104,302 | 72,340 | 176,643 |
| 1996 | 88,554 | 48,148 | 136,702 |
| 1997 | 80,447 | 28,252 | 108,699 |
| 1998 | 62,176 | 25,841 | 88,017 |
| 1999 | 48,035 | 42,342 | 90,377 |
| 2000 | 69,249 | 33,159 | 102,408 |
| 2001 | 113,677 | 79,646 | 193,323 |
| 2002 | 90,748 | 94,233 | 184,981 |
| 2003 | 71,035 | 65,085 | 136,120 |
| 2004 | 97,898 | 71,348 | 169,246 |
| 2005 | 71,526 | 55,671 | 127,198 |
| 2006 | 55,910 | 28,468 | 84,377 |
| 2007 | 85,062 | 27,123 | 112,186 |
| 2008 | 186,042 | 60,916 | 246,958 |
| 2009 | 291,812 | 57,338 | 349,151 |

**Table 3.4.** Red snapper landings (pounds whole weight) by gear (handline and diving) from the U.S. South Atlantic, 1950-2009. Percent of landings in numbers by handline also shown.

| Year | Handline | Diving | Total | %Handline |
|---|---|---|---|---|
| 1950 | 358,200 | 0 | 358,200 | 100.00% |
| 1951 | 517,600 | 0 | 517,600 | 100.00% |
| 1952 | 389,300 | 0 | 389,300 | 100.00% |
| 1953 | 401,900 | 0 | 401,900 | 100.00% |
| 1954 | 598,600 | 0 | 598,600 | 100.00% |
| 1955 | 497,800 | 0 | 497,800 | 100.00% |
| 1956 | 484,300 | 0 | 484,300 | 100.00% |
| 1957 | 868,900 | 0 | 868,900 | 100.00% |
| 1958 | 617,300 | 0 | 617,300 | 100.00% |
| 1959 | 662,700 | 0 | 662,700 | 100.00% |
| 1960 | 677,100 | 0 | 677,100 | 100.00% |
| 1961 | 799,800 | 0 | 799,800 | 100.00% |
| 1962 | 662,546 | 0 | 662,546 | 100.00% |
| 1963 | 504,839 | 0 | 504,839 | 100.00% |
| 1964 | 559,456 | 0 | 559,456 | 100.00% |
| 1965 | 656,726 | 0 | 656,726 | 100.00% |
| 1966 | 740,057 | 0 | 740,057 | 100.00% |
| 1967 | 963,692 | 0 | 963,692 | 100.00% |
| 1968 | 1,069,170 | 0 | 1,069,170 | 100.00% |
| 1969 | 700,423 | 0 | 700,423 | 100.00% |
| 1970 | 640,866 | 0 | 640,866 | 100.00% |
| 1971 | 543,399 | 0 | 543,399 | 100.00% |
| 1972 | 468,535 | 0 | 468,535 | 100.00% |
| 1973 | 387,270 | 0 | 387,270 | 100.00% |
| 1974 | 632,450 | 0 | 632,450 | 100.00% |
| 1975 | 745,339 | 0 | 745,339 | 100.00% |
| 1976 | 618,842 | 0 | 618,842 | 100.00% |
| 1977 | 648,943 | 0 | 648,943 | 100.00% |
| 1978 | 589,500 | 0 | 589,500 | 100.00% |
| 1979 | 409,723 | 0 | 409,723 | 100.00% |
| 1980 | 380,355 | 0 | 380,355 | 100.00% |

**Table 3.4 continued**

| | | | | |
|---|---|---|---|---|
| 1981 | 371,140 | 0 | 371,140 | 100.00% |
| 1982 | 305,868 | 0 | 305,868 | 100.00% |
| 1983 | 309,993 | 0 | 309,993 | 100.00% |
| 1984 | 247,949 | 1,317 | 249,266 | 99.47% |
| 1985 | 240,803 | 2,547 | 243,349 | 98.95% |
| 1986 | 215,634 | 508 | 216,143 | 99.76% |
| 1987 | 187,076 | 30 | 187,106 | 99.98% |
| 1988 | 163,942 | 13 | 163,954 | 99.99% |
| 1989 | 258,117 | 6 | 258,123 | 100.00% |
| 1990 | 214,759 | 1,859 | 216,617 | 99.14% |
| 1991 | 133,869 | 5,898 | 139,767 | 95.78% |
| 1992 | 88,964 | 9,614 | 98,578 | 90.25% |
| 1993 | 189,646 | 5,611 | 195,257 | 97.13% |
| 1994 | 179,363 | 13,116 | 192,479 | 93.19% |
| 1995 | 166,605 | 10,037 | 176,643 | 94.32% |
| 1996 | 130,549 | 6,153 | 136,702 | 95.50% |
| 1997 | 101,169 | 7,531 | 108,699 | 93.07% |
| 1998 | 79,954 | 8,063 | 88,017 | 90.84% |
| 1999 | 80,403 | 9,974 | 90,377 | 88.96% |
| 2000 | 92,032 | 10,376 | 102,408 | 89.87% |
| 2001 | 175,085 | 18,238 | 193,323 | 90.57% |
| 2002 | 162,886 | 22,095 | 184,981 | 88.06% |
| 2003 | 118,669 | 17,451 | 136,120 | 87.18% |
| 2004 | 149,603 | 19,643 | 169,246 | 88.39% |
| 2005 | 117,857 | 9,341 | 127,198 | 92.66% |
| 2006 | 80,216 | 4,161 | 84,377 | 95.07% |
| 2007 | 104,672 | 7,514 | 112,186 | 93.30% |
| 2008 | 240,655 | 6,303 | 246,958 | 97.45% |
| 2009 | 341,142 | 8,009 | 349,151 | 97.71% |

**Table 3.5.** Sample size of red snapper collected for lengths by gear (handline and diving) and state from the U.S. South Atlantic TIP data base, 1984-2009.

| Sum of sum | Column Labels | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | DIVING | | | DIVING Total | HAND LINES | | | | HAND LINES Total |
| Row Labels | FL | GA | SC | | FL | GA | NC | SC | |
| 1984 | | | | | | 206 | 109 | 987 | 1302 |
| 1985 | | | | | 639 | 146 | 489 | 1276 | 2550 |
| 1986 | | | | | 24 | 110 | 507 | 267 | 908 |
| 1987 | | | | | | 403 | 277 | 385 | 1065 |
| 1988 | | | | | 5 | 233 | 169 | 259 | 666 |
| 1989 | | | | | 37 | 191 | 471 | 330 | 1029 |
| 1990 | | | | | 164 | | 412 | 128 | 704 |
| 1991 | | | | | 70 | 199 | 159 | 400 | 828 |
| 1992 | | | | | 90 | 110 | 55 | 99 | 354 |
| 1993 | 1 | | | 1 | 189 | 128 | 188 | 280 | 785 |
| 1994 | | 1 | | 1 | 89 | 77 | 448 | 211 | 825 |
| 1995 | 4 | | | 4 | 365 | 36 | 118 | 132 | 651 |
| 1996 | | | | | 21 | 40 | 54 | 232 | 347 |
| 1997 | | | | | 27 | 7 | 1 | 190 | 225 |
| 1998 | | | | | 156 | | 16 | 143 | 315 |
| 1999 | 81 | | | 81 | 216 | | 180 | 494 | 890 |
| 2000 | 87 | | | 87 | 234 | 24 | 59 | 427 | 744 |
| 2001 | 53 | | | 53 | 373 | 257 | 279 | 450 | 1359 |
| 2002 | 9 | | | 9 | 87 | 68 | 193 | 447 | 795 |
| 2003 | 197 | | | 197 | 303 | 43 | 164 | 620 | 1130 |
| 2004 | | | 15 | 15 | 31 | 132 | 71 | 444 | 678 |
| 2005 | | | 7 | 7 | 7 | 94 | 96 | 362 | 559 |
| 2006 | | | 15 | 15 | 8 | 13 | 62 | 114 | 197 |
| 2007 | | | | | 41 | | 97 | 141 | 279 |
| 2008 | | | | | 7 | | 172 | 223 | 402 |
| 2009 | | | 21 | 21 | 64 | | 163 | 359 | 586 |
| **Grand Total** | **432** | **1** | **58** | **491** | **3247** | **2517** | **5009** | **9400** | **20173** |

**Table 3.6.** Mean whole weight (pounds) of red snapper by gear (handline and diving) from the U.S. South Atlantic TIP data base, 1984-2009. Average weights by gear applied to earlier years, 1950-1983.

| Sum of MEAN_weight | Column Labels | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DIVING | | | | HAND LINES | | | |
| Row Labels | FL | GA | NC | SC | FL | GA | NC | SC |
| 1984 | 6.346 | 6.346 | 6.346 | 6.346 | 4.948 | 3.355 | 6.059 | 3.701 |
| 1985 | 6.346 | 6.346 | 6.346 | 6.346 | 4.294 | 5.456 | 4.925 | 5.361 |
| 1986 | 6.346 | 6.346 | 6.346 | 6.346 | 8.971 | 7.571 | 4.618 | 5.922 |
| 1987 | 6.346 | 6.346 | 6.346 | 6.346 | 4.948 | 4.579 | 6.275 | 6.539 |
| 1988 | 6.346 | 6.346 | 6.346 | 6.346 | 4.948 | 6.333 | 3.703 | 4.886 |
| 1989 | 6.346 | 6.346 | 6.346 | 6.346 | 12.275 | 5.048 | 5.127 | 6.089 |
| 1990 | 6.346 | 6.346 | 6.346 | 6.346 | 5.673 | 4.948 | 4.934 | 2.991 |
| 1991 | 6.346 | 6.346 | 6.346 | 6.346 | 8.330 | 6.234 | 5.488 | 3.717 |
| 1992 | 8.257 | 8.257 | 8.257 | 8.257 | 12.173 | 8.770 | 8.176 | 7.719 |
| 1993 | 8.257 | 8.257 | 8.257 | 8.257 | 12.961 | 6.844 | 5.853 | 5.971 |
| 1994 | 8.257 | 8.257 | 8.257 | 8.257 | 11.099 | 6.619 | 6.732 | 6.308 |
| 1995 | 8.257 | 8.257 | 8.257 | 8.257 | 9.318 | 7.360 | 11.734 | 8.099 |
| 1996 | 8.257 | 8.257 | 8.257 | 8.257 | 10.928 | 7.134 | 7.499 | 9.471 |
| 1997 | 8.257 | 8.257 | 8.257 | 8.257 | 8.693 | 8.089 | 8.089 | 10.873 |
| 1998 | 8.257 | 8.257 | 8.257 | 8.257 | 7.174 | 8.089 | 8.089 | 10.353 |
| 1999 | 9.761 | 8.257 | 8.257 | 8.257 | 6.834 | 8.089 | 4.059 | 8.592 |
| 2000 | 6.072 | 8.257 | 8.257 | 8.257 | 7.719 | 6.543 | 8.654 | 10.511 |
| 2001 | 8.059 | 8.257 | 8.257 | 8.257 | 6.789 | 3.553 | 6.208 | 7.783 |
| 2002 | 8.257 | 8.257 | 8.257 | 8.257 | 8.435 | 5.589 | 6.669 | 7.383 |
| 2003 | 8.408 | 8.257 | 8.257 | 8.257 | 9.441 | 7.883 | 9.685 | 7.994 |
| 2004 | 8.257 | 8.257 | 8.257 | 8.257 | 9.931 | 9.328 | 12.174 | 9.068 |
| 2005 | 8.257 | 8.257 | 8.257 | 8.257 | 8.089 | 10.093 | 11.777 | 10.359 |
| 2006 | 8.257 | 8.257 | 8.257 | 8.257 | 8.089 | 8.089 | 12.467 | 12.130 |
| 2007 | 8.257 | 8.257 | 8.257 | 8.257 | 7.766 | 8.089 | 5.351 | 10.459 |
| 2008 | 8.257 | 8.257 | 8.257 | 8.257 | 8.089 | 8.089 | 6.039 | 7.451 |
| 2009 | 8.257 | 8.257 | 8.257 | 7.456 | 10.227 | 8.089 | 5.262 | 9.389 |

**Table 3.7.** Red snapper landings (in numbers) by gear from the U.S. South Atlantic, 1950-2009. Percent of landings in numbers by handline also shown.

| Year | Handline | Diving | Total | %Handline |
|---|---|---|---|---|
| 1950 | 72,386 | 0 | 72,386 | 100.00% |
| 1951 | 104,598 | 0 | 104,598 | 100.00% |
| 1952 | 78,671 | 0 | 78,671 | 100.00% |
| 1953 | 81,217 | 0 | 81,217 | 100.00% |
| 1954 | 120,967 | 0 | 120,967 | 100.00% |
| 1955 | 100,597 | 0 | 100,597 | 100.00% |
| 1956 | 97,869 | 0 | 97,869 | 100.00% |
| 1957 | 175,590 | 0 | 175,590 | 100.00% |
| 1958 | 124,746 | 0 | 124,746 | 100.00% |
| 1959 | 133,921 | 0 | 133,921 | 100.00% |
| 1960 | 136,831 | 0 | 136,831 | 100.00% |
| 1961 | 161,626 | 0 | 161,626 | 100.00% |
| 1962 | 133,899 | 0 | 133,899 | 100.00% |
| 1963 | 102,030 | 0 | 102,030 | 100.00% |
| 1964 | 113,065 | 0 | 113,065 | 100.00% |
| 1965 | 132,728 | 0 | 132,728 | 100.00% |
| 1966 | 149,554 | 0 | 149,554 | 100.00% |
| 1967 | 195,088 | 0 | 195,088 | 100.00% |
| 1968 | 216,198 | 0 | 216,198 | 100.00% |
| 1969 | 141,640 | 0 | 141,640 | 100.00% |
| 1970 | 129,616 | 0 | 129,616 | 100.00% |
| 1971 | 110,156 | 0 | 110,156 | 100.00% |
| 1972 | 95,020 | 0 | 95,020 | 100.00% |
| 1973 | 78,396 | 0 | 78,396 | 100.00% |
| 1974 | 128,081 | 0 | 128,081 | 100.00% |
| 1975 | 150,815 | 0 | 150,815 | 100.00% |
| 1976 | 125,433 | 0 | 125,433 | 100.00% |
| 1977 | 131,638 | 0 | 131,638 | 100.00% |
| 1978 | 119,815 | 0 | 119,815 | 100.00% |
| 1979 | 83,010 | 0 | 83,010 | 100.00% |
| 1980 | 77,016 | 0 | 77,016 | 100.00% |
| 1981 | 75,190 | 0 | 75,190 | 100.00% |

**Table 3.7 continued**

| | | | | |
|---|---|---|---|---|
| 1982 | 61,923 | 0 | 61,923 | 100.00% |
| 1983 | 62,734 | 0 | 62,734 | 100.00% |
| 1984 | 56,014 | 209 | 56,223 | 99.63% |
| 1985 | 52,308 | 401 | 52,710 | 99.24% |
| 1986 | 29,455 | 80 | 29,535 | 99.73% |
| 1987 | 36,163 | 5 | 36,168 | 99.99% |
| 1988 | 33,564 | 2 | 33,566 | 99.99% |
| 1989 | 34,782 | 1 | 34,783 | 100.00% |
| 1990 | 49,550 | 293 | 49,842 | 99.41% |
| 1991 | 23,227 | 929 | 24,156 | 96.15% |
| 1992 | 9,052 | 1,164 | 10,216 | 88.61% |
| 1993 | 26,843 | 680 | 27,523 | 97.53% |
| 1994 | 23,393 | 1,568 | 24,961 | 93.72% |
| 1995 | 18,675 | 1,215 | 19,890 | 93.89% |
| 1996 | 13,472 | 742 | 14,214 | 94.78% |
| 1997 | 11,460 | 910 | 12,370 | 92.64% |
| 1998 | 10,432 | 974 | 11,407 | 91.46% |
| 1999 | 11,751 | 1,022 | 12,772 | 92.00% |
| 2000 | 11,427 | 1,702 | 13,129 | 87.04% |
| 2001 | 29,168 | 2,226 | 31,395 | 92.91% |
| 2002 | 22,384 | 2,666 | 25,050 | 89.36% |
| 2003 | 13,660 | 2,069 | 15,729 | 86.84% |
| 2004 | 15,449 | 2,358 | 17,808 | 86.76% |
| 2005 | 13,075 | 1,129 | 14,204 | 92.05% |
| 2006 | 8,971 | 503 | 9,474 | 94.69% |
| 2007 | 13,405 | 899 | 14,304 | 93.72% |
| 2008 | 30,448 | 760 | 31,208 | 97.56% |
| 2009 | 35,219 | 972 | 36,192 | 97.31% |

**Table 3.8.** Estimated coefficients of variation to be applied to commercial landings.

| Year | Florida | Georgia | South Carolina | North Carolina |
|---|---|---|---|---|
| 1950 | 50% | 50% | 50% | 50% |
| 1951 | 50% | 50% | 50% | 50% |
| 1952 | 50% | 50% | 50% | 50% |
| 1953 | 50% | 50% | 50% | 50% |
| 1954 | 50% | 50% | 50% | 50% |
| 1955 | 50% | 50% | 50% | 50% |
| 1956 | 50% | 50% | 50% | 50% |
| 1957 | 50% | 50% | 50% | 50% |
| 1958 | 50% | 50% | 50% | 50% |
| 1959 | 50% | 50% | 50% | 50% |
| 1960 | 50% | 50% | 50% | 50% |
| 1961 | 50% | 50% | 50% | 50% |
| 1962 | 40% | 40% | 40% | 40% |
| 1963 | 40% | 40% | 40% | 40% |
| 1964 | 40% | 40% | 40% | 40% |
| 1965 | 40% | 40% | 40% | 40% |
| 1966 | 40% | 40% | 40% | 40% |
| 1967 | 40% | 40% | 40% | 40% |
| 1968 | 40% | 40% | 40% | 40% |
| 1969 | 40% | 40% | 40% | 40% |
| 1970 | 40% | 40% | 40% | 40% |
| 1971 | 40% | 40% | 40% | 40% |
| 1972 | 40% | 40% | 40% | 40% |
| 1973 | 40% | 40% | 40% | 40% |
| 1974 | 40% | 40% | 40% | 40% |
| 1975 | 40% | 40% | 40% | 40% |
| 1976 | 40% | 40% | 40% | 40% |
| 1977 | 40% | 40% | 40% | 40% |
| 1978 | 40% | 40% | 40% | 40% |
| 1979 | 40% | 40% | 40% | 40% |
| 1980 | 40% | 40% | 40% | 40% |
| 1981 | 40% | 20% | 20% | 20% |

**Table 3.8 continued**

| | | | | |
|---|---|---|---|---|
| 1982 | 40% | 20% | 20% | 20% |
| 1983 | 40% | 20% | 20% | 20% |
| 1984 | 40% | 20% | 20% | 20% |
| 1985 | 40% | 20% | 20% | 20% |
| 1986 | 20% | 20% | 20% | 20% |
| 1987 | 20% | 20% | 20% | 20% |
| 1988 | 20% | 20% | 20% | 20% |
| 1989 | 20% | 20% | 20% | 20% |
| 1990 | 20% | 20% | 20% | 20% |
| 1991 | 20% | 20% | 20% | 20% |
| 1992 | 20% | 20% | 20% | 20% |
| 1993 | 20% | 20% | 20% | 20% |
| 1994 | 20% | 20% | 20% | 10% |
| 1995 | 20% | 20% | 20% | 10% |
| 1996 | 20% | 20% | 20% | 10% |
| 1997 | 10% | 20% | 20% | 10% |
| 1998 | 10% | 20% | 20% | 10% |
| 1999 | 10% | 20% | 20% | 10% |
| 2000 | 10% | 20% | 20% | 10% |
| 2001 | 10% | 20% | 20% | 10% |
| 2002 | 10% | 10% | 20% | 10% |
| 2003 | 10% | 10% | 20% | 10% |
| 2004 | 10% | 10% | 10% | 10% |
| 2005 | 10% | 10% | 10% | 10% |
| 2006 | 10% | 10% | 10% | 10% |
| 2007 | 10% | 10% | 10% | 10% |
| 2008 | 10% | 10% | 10% | 10% |
| 2009 | 10% | 10% | 10% | 10% |

**Table 3.9.** Calculated yearly South Atlantic vertical line vessel red snapper discards from SEDAR 15, continuity case, bootstrapped values of discards, and delta-lognormal method. Discards are reported in number of fish.

| Year | Calculated Discards 2007 | Calculated Discards 2010 (2007 method) | Calculated Discards 2010 (bootstrap median) | Calculated Discards 2010 (bootstrap 5th percentile) | Calculated Discards 2010 (bootstrap 95th percentile) | Calculated Discards 2010 (delta-lognormal method)** |
|---|---|---|---|---|---|---|
| 1992* | 18,292 | 15,370 | 15,354 | 13,237 | 17,674 | 14,233 |
| 1993 | 17,860 | 19,198 | 19,185 | 16,745 | 21,857 | 14,926 |
| 1994 | 24,459 | 25,068 | 25,056 | 21,972 | 28,428 | 20,638 |
| 1995 | 24,153 | 28,683 | 28,657 | 24,820 | 32,865 | 19,437 |
| 1996 | 32,254 | 39,624 | 39,586 | 34,192 | 45,506 | 24,867 |
| 1997 | 33,725 | 38,405 | 38,373 | 33,303 | 43,935 | 27,458 |
| 1998 | 25,524 | 27,691 | 27,672 | 24,135 | 31,546 | 21,106 |
| 1999 | 22,959 | 24,129 | 24,112 | 21,030 | 27,492 | 19,387 |
| 2000 | 21,810 | 22,859 | 22,844 | 19,970 | 25,991 | 18,975 |
| 2001 | 23,680 | 24,828 | 24,817 | 21,741 | 28,177 | 19,014 |
| 2002 | 22,133 | 24,275 | 24,260 | 21,155 | 27,657 | 42,356 |
| 2003 | 18,937 | 20,297 | 20,284 | 17,704 | 23,109 | 13,973 |
| 2004 | 15,813 | 17,017 | 17,005 | 14,836 | 19,381 | 5,170 |
| 2005 | 15,272 | 16,593 | 16,583 | 14,478 | 18,884 | 4,999 |
| 2006 | 16,914 | 18,800 | 18,789 | 16,410 | 21,389 | 7,425 |
| 2007 | | 23,610 | 23,588 | 20,394 | 27,090 | 14,759 |
| 2008 | | 22,360 | 22,342 | 19,388 | 25,578 | 15,512 |
| 2009 | | 22,180 | 22,165 | 19,288 | 25,315 | 20,402 |

* In 1992 only 20% of vessels in Florida were required to report to the logbook program; calculated discards for areas off Florida (region 1) were expanded by a factor of five.

** As recommended by the Commercial Workgroup and accepted by the Plenary

**Table 3.10.** Sample size for fish lengths from observer data with associated depth distributed by latitude and longitude, 2007-2009.

| Sample Size | Longitude | | | | |
|---|---|---|---|---|---|
| Latitude | 77 | 78 | 79 | 80 | Latitude Total |
| 30 | | | 6 | 253 | 259 |
| 31 | | | 53 | 38 | 91 |
| 32 | | 1 | 29 | | 30 |
| 33 | 3 | | | | 3 |
| Longitude Total | 3 | 1 | 88 | 291 | 383 |

**Table 3.11.** Percent logbook catch and observer discards by 25 ft depth intervals and corresponding discard mortality calculated from Burns et al (= 1/(1 + exp(-2.3915 + 0.0592*depth in meters))). Weighted average discard mortality is shown at bottom, weighted either by logbook catch (depth information for 2004-2009) or observer discards (2007-2009). [1 meter = 39.37 inches]

| Depth Intervals Mid-pt (ft) | Logbook Catch | Observer Discards | Burns et al. Discard-M |
|---|---|---|---|
| 12.5 | 0.6% | | 10.3% |
| 37.5 | 0.1% | | 15.3% |
| 62.5 | 1.9% | 0.8% | 22.0% |
| 87.5 | 3.3% | 4.4% | 30.7% |
| 112.5 | 30.1% | 47.5% | 41.1% |
| 137.5 | 22.6% | 25.3% | 52.2% |
| 162.5 | 20.8% | 19.1% | 63.2% |
| 187.5 | 10.0% | 1.8% | 72.9% |
| 212.5 | 8.0% | 1.0% | 80.9% |
| 237.5 | 0.8% | | 86.9% |
| 262.5 | 1.4% | | 91.3% |
| 287.5 | 0.4% | | 94.2% |
| 312.5 | 0.1% | | 96.3% |
| 337.5 | 0.0% | | 97.6% |
| 362.5 | 0.0% | | 98.4% |
| 387.5 | 0.0% | | 99.0% |
| 412.5 | 0.0% | | 99.4% |
| 462.5 | 0.0% | | 99.7% |
| 487.5 | 0.0% | | 99.8% |
| 512.5 | 0.0% | | 99.9% |
| 612.5 | 0.0% | | 100.0% |
| 812.5 | 0.0% | | 100.0% |
| 912.5 | 0.0% | | 100.0% |
| | 55.0% | 48.5% | |

**Table 3.12.** Sample size of aged red snapper by gear, state and year from commercial landings in the U.S. South Atlantic, 1980-2009 provided by the Life History Workgroup [see text for minimum sample size discussion].

| Count of Source | Pooled Gears State | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Diver | | | Handline | | | | Grand Total |
| Year | FL | GA | SC | FL | GA | NC | SC | |
| 1980 | | | | | 2 | | 12 | 14 |
| 1981 | | | | | | | 1 | 1 |
| 1988 | | | | | | | 41 | 41 |
| 1989 | | | | | | | 8 | 8 |
| 1990 | | | | | | | 28 | 28 |
| 1991 | | | | | | | 28 | 28 |
| 1992 | | | | 15 | | | 33 | 48 |
| 1993 | | | | 7 | | | 30 | 37 |
| 1994 | | | | 1 | | | 48 | 49 |
| 1995 | | | | 16 | | | 12 | 28 |
| 1996 | | | | 131 | 8 | | 32 | 171 |
| 1997 | | | | 63 | 5 | | 123 | 191 |
| 1998 | | | | 54 | | | 21 | 75 |
| 1999 | | | | 13 | | | 151 | 164 |
| 2000 | 123 | | 1 | 97 | 28 | | 169 | 418 |
| 2001 | 4 | 26 | | 151 | | | | 181 |
| 2002 | | | | 35 | | | 3 | 38 |
| 2003 | | | | 49 | | 2 | | 51 |
| 2004 | | | | 64 | | 39 | | 103 |
| 2005 | | | | 46 | | 61 | 34 | 141 |
| 2006 | | | | 53 | | 44 | 114 | 211 |
| 2007 | 1 | | 3 | 86 | | 91 | 115 | 296 |
| 2008 | | | | 58 | | 175 | 203 | 436 |
| 2009 | 46 | | 12 | 2187 | | 161 | 276 | 2682 |
| Grand Total | 174 | 26 | 16 | 3126 | 43 | 573 | 1482 | 5440 |

**Table 3.13.** Red snapper longline landings (pounds) from the NMFS ALS data base, 1962-2009. No red snapper longline landings were reported in 1962, 1964-1968, 1970-1977, and 1979.

| Sum of WHOLE_POUNDS | Column Labels | | | | |
|---|---|---|---|---|---|
| **Row Labels** | **FL** | **GA** | **SC** | **NC** | **Grand Total** |
| 1963 | 1,500 | | | | 1,500 |
| 1969 | | 1,900 | | | 1,900 |
| 1978 | | | | 124 | 124 |
| 1980 | 654 | | | 508 | 1,162 |
| 1981 | | 76 | | | 76 |
| 1982 | | | 573 | | 573 |
| 1983 | | 739 | 1,198 | 85 | 2,021 |
| 1984 | 1,612 | 890 | 224 | 72 | 2,798 |
| 1985 | | | 157 | | 157 |
| 1986 | 275 | | 207 | 77 | 559 |
| 1987 | 61 | 3 | 12 | 1,685 | 1,761 |
| 1988 | 110 | | 6 | 1,403 | 1,518 |
| 1989 | 33 | | 63 | 209 | 305 |
| 1990 | 1,862 | | 2,665 | 135 | 4,662 |
| 1991 | 1,514 | | 51 | 420 | 1,985 |
| 1992 | 259 | 22 | | 160 | 442 |
| 1993 | 251 | 25 | | 235 | 511 |
| 1994 | 610 | 17 | | 49 | 676 |
| 1995 | 104 | | | | 104 |
| 1996 | 1,460 | | | 11 | 1,471 |
| 1997 | 4,982 | | 15 | | 4,996 |
| 1998 | 2,831 | | | | 2,831 |
| 1999 | 1,109 | | | | 1,109 |
| 2000 | 1,280 | | | | 1,280 |
| 2001 | 1,555 | | | | 1,555 |
| 2002 | 429 | 86 | 1,170 | | 1,685 |
| 2003 | 1,997 | | 120 | | 2,116 |
| 2004 | 699 | | | | 699 |
| 2005 | 208 | | | | 208 |
| 2006 | 521 | | | | 521 |
| 2007 | 230 | | | | 230 |
| 2008 | | | 58 | | 58 |
| 2009 | 148 | | | | 148 |
| **Grand Total** | **26,294** | **3,758** | **6,518** | **5,171** | **41,741** |

**Table 3.14.** TIP red snapper samples available from the longline gear by state.

| Sum of sum | Column Labels | | | | |
|---|---|---|---|---|---|
| | LONG LINES | | | LONG LINES Total | Grand Total |
| Row Labels | FL | NC | SC | | |
| 1986 | | 1 | | 1 | 1 |
| 1987 | | 81 | | 81 | 81 |
| 1988 | | 12 | 1 | 13 | 13 |
| 1989 | | 8 | | 8 | 8 |
| 1990 | 17 | 5 | 1 | 23 | 23 |
| 1991 | | 2 | | 2 | 2 |
| 1992 | 3 | | | 3 | 3 |
| 1993 | 4 | | | 4 | 4 |
| 1994 | 2 | | | 2 | 2 |
| 1995 | 8 | | | 8 | 8 |
| 1996 | 8 | | | 8 | 8 |
| 1997 | 10 | | | 10 | 10 |
| 1998 | 2 | | | 2 | 2 |
| **Grand Total** | **54** | **109** | **2** | **165** | **165** |

## 3.10 Figures

**Figure 3.1.** Map of U.S. Atlantic and Gulf coast with shrimp area designations.

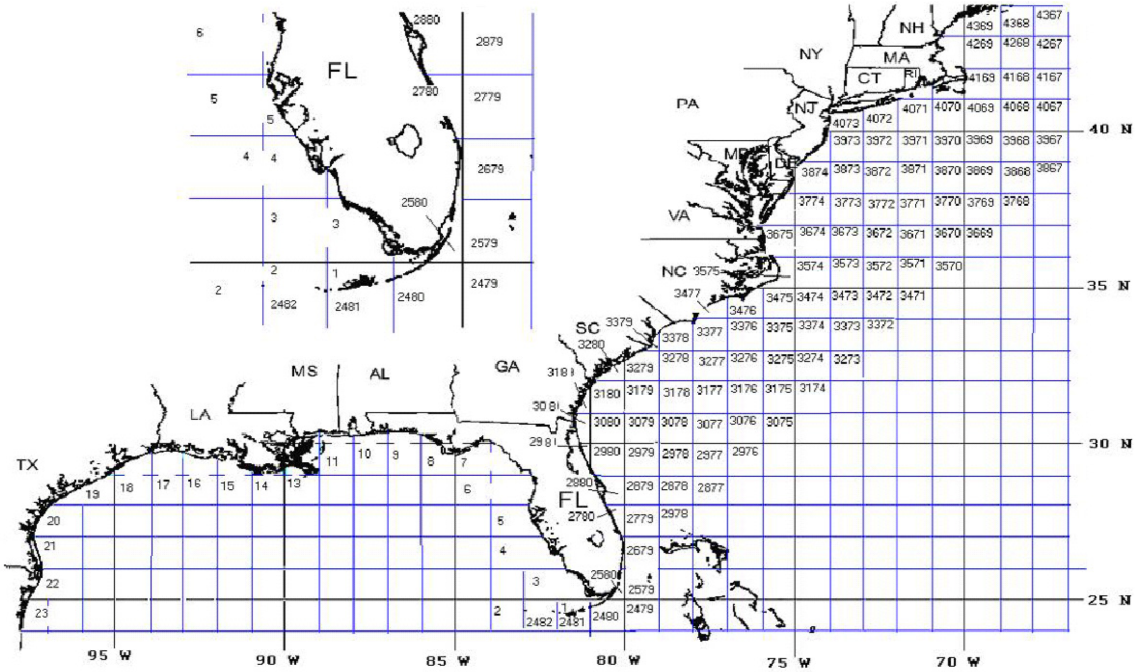



**Figure 3.2.** Map showing marine fisheries trip ticket fishing area code map for Florida.

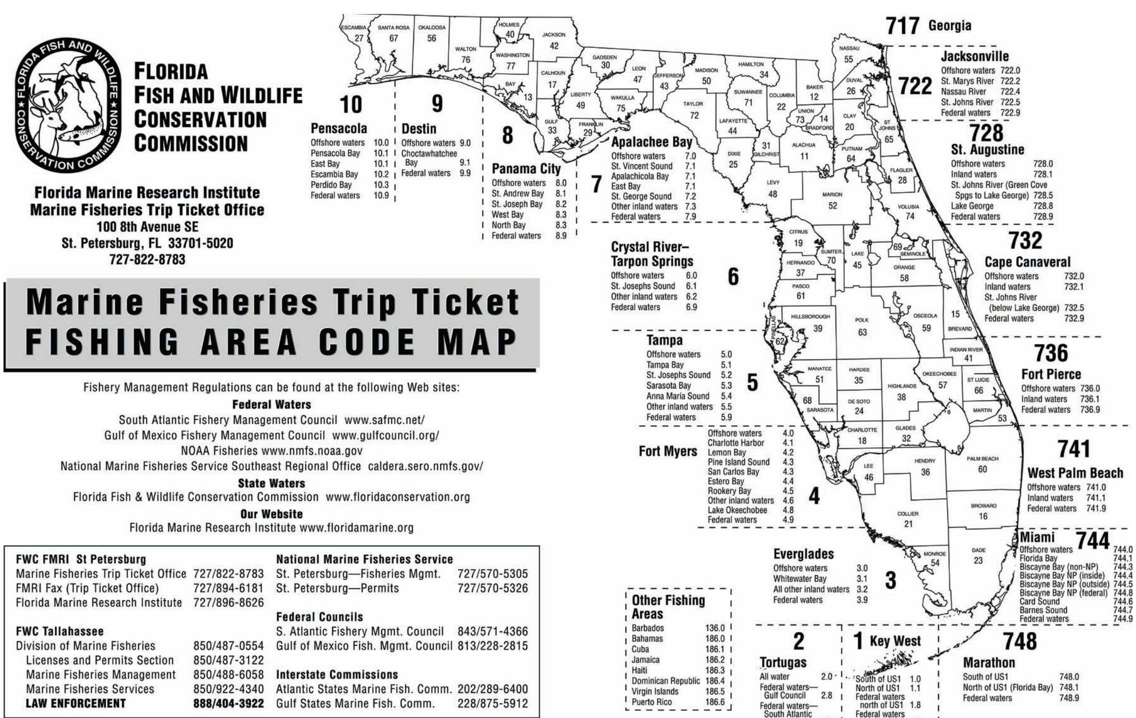


**Figure 3.3.** Historical red snapper landings by gear from the U.S. South Atlantic, 1902-1989. (Source: Fisheries Statistics Division. 1990. *Historical Catch Statistics, Atlantic and Gulf Coast States, 1879-1989*, US DOC/NOAA/NMFS, Current Fishery Statistics No. 9010, Historical Series Nos. 5-9).

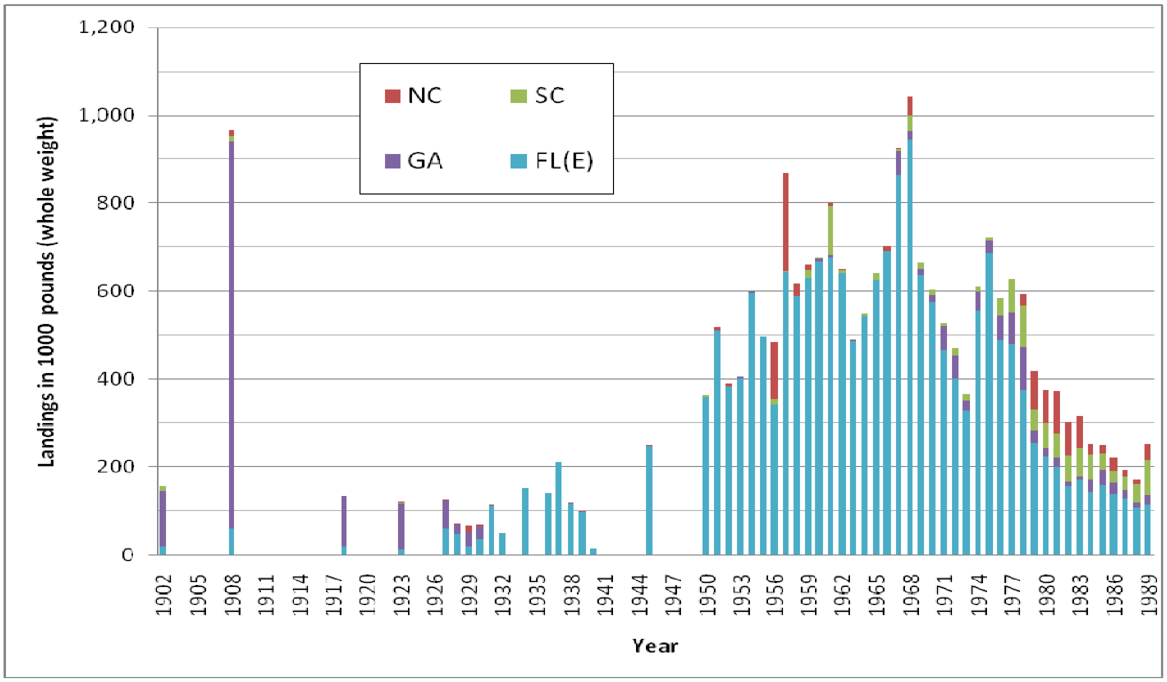



**Figure 3.4.** Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse - data sources and collection methods by state.

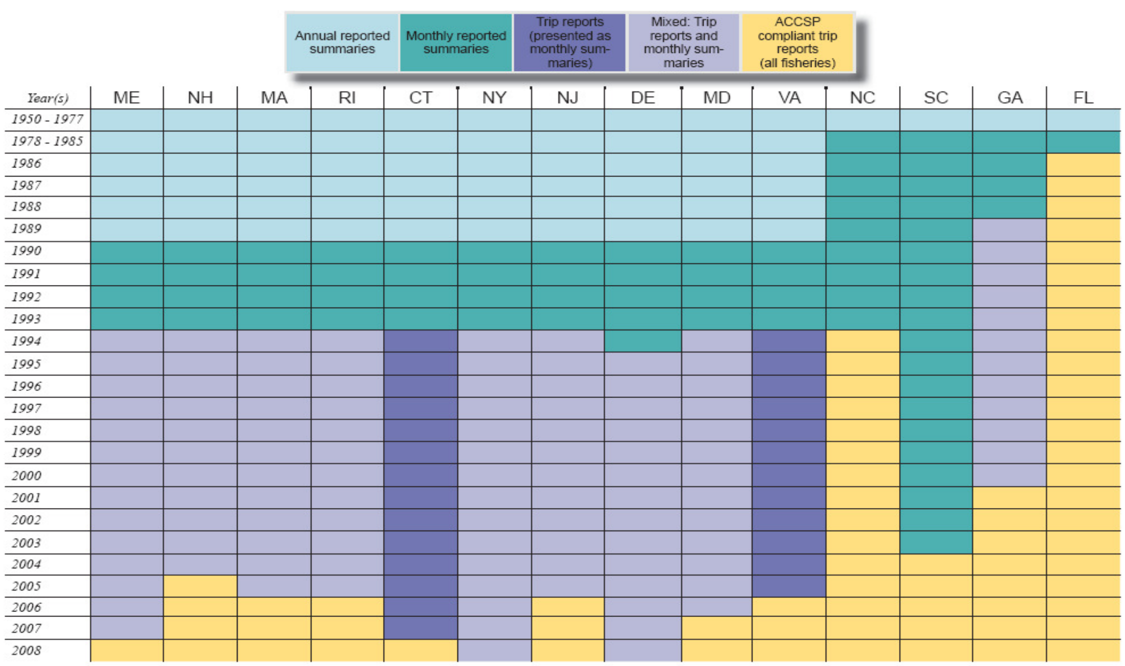


**Figure 3.5.** Red snapper landings in pounds (whole weight) by state from the U.S. South Atlantic, 1950-2010.

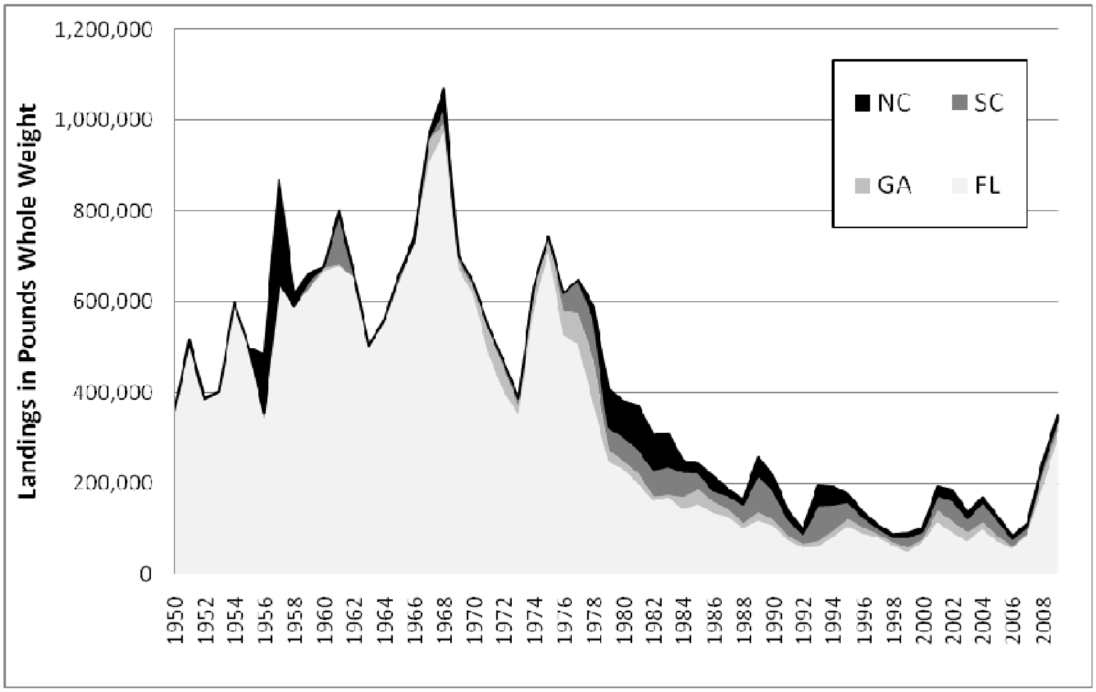



**Figure 3.6.** Red snapper landings in pounds (whole weight) by gear (reduced to handline and diving) from the U.S. South Atlantic, 1950-2010.

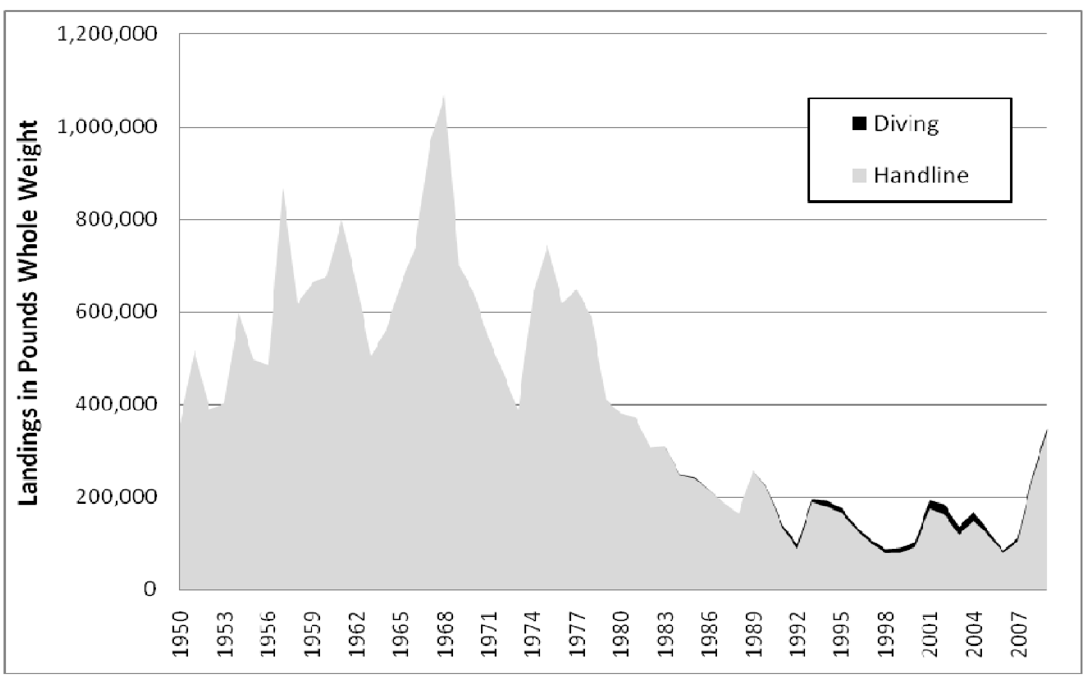


**Figure 3.7.** Red snapper (a) trips and (b) catchesby latitude and longitude from the snapper grouper logbook data base for 1993-2009.

**(a) Trips**

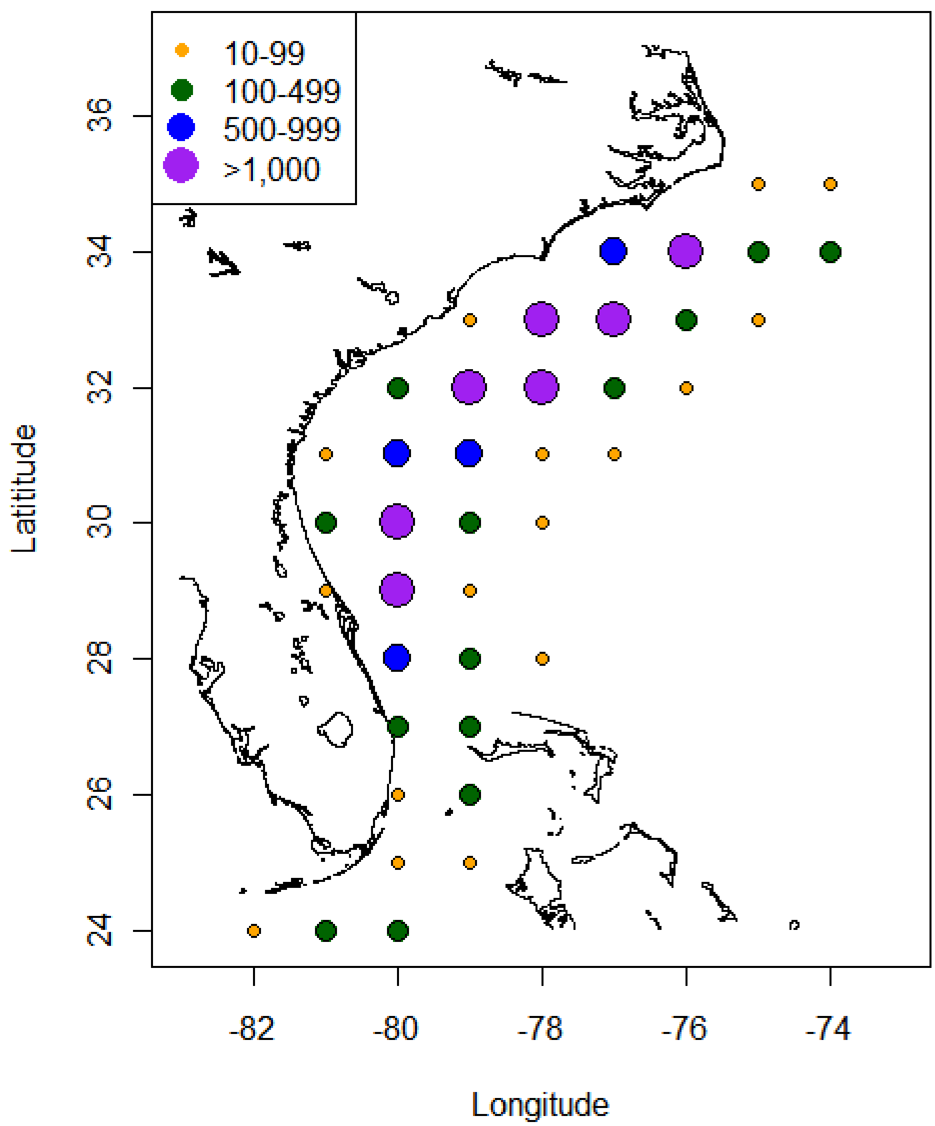


**Figure 3.7.** (cont.)

**(b) Catches (pounds)**

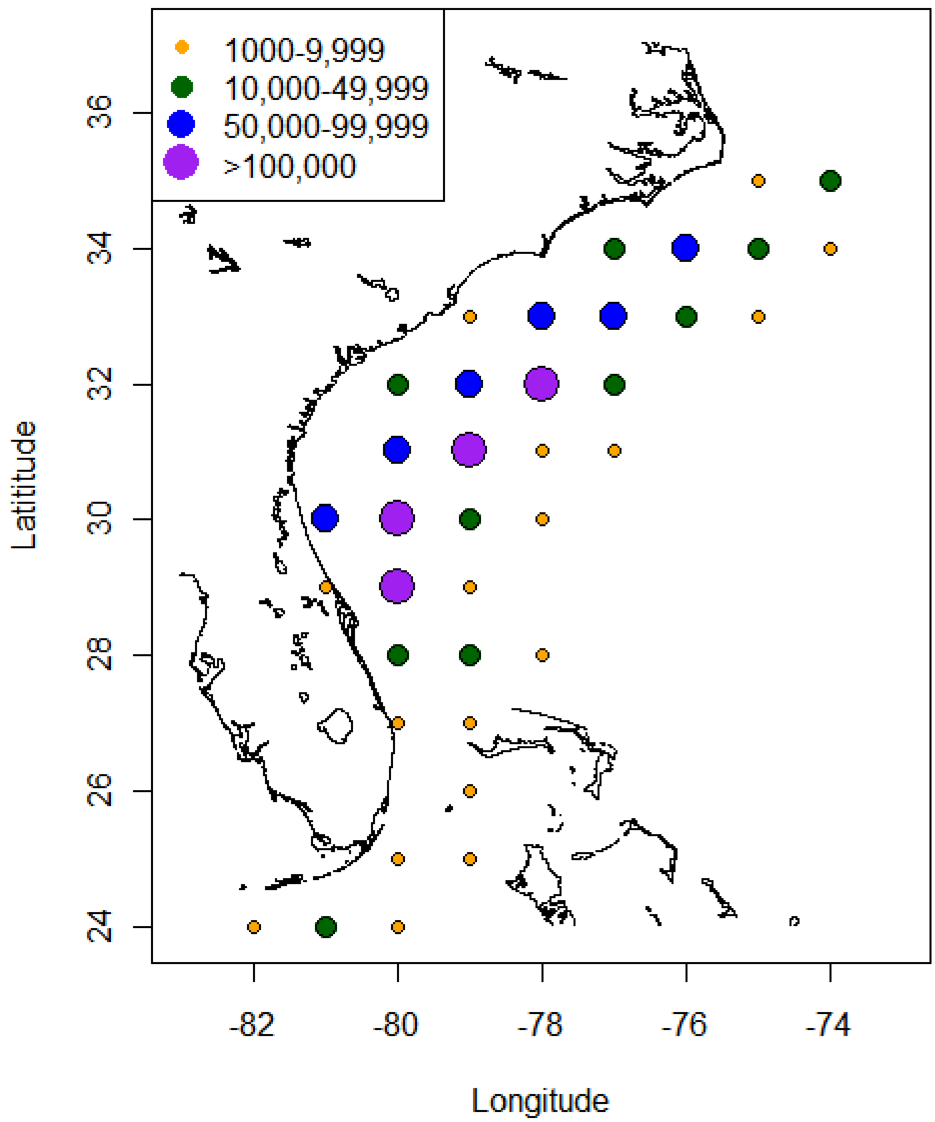


**Figure 3.8.** Map of U.S. South Atlantic coast showing 30 m – 60 m (yellow) representing contour where most of the commercial handline landing come from according to logbook data, and 60 m – 80 m (red). [Provided by Dr. Don Field, NOS, Beaufort, NC]

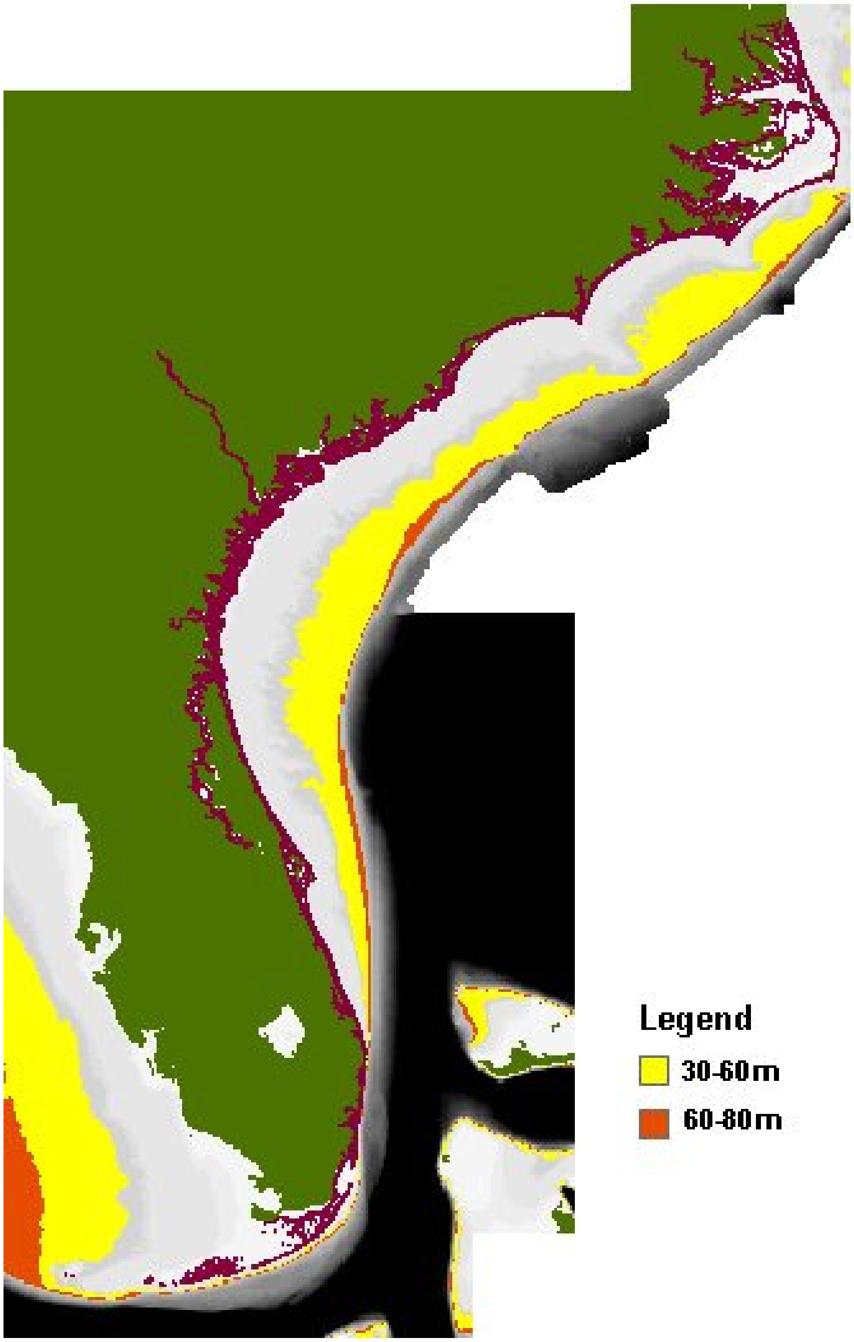


**Figure 3.9**. Red snapper landings in numbers by gear (handline and diving) from the U.S. South Atlantic, 1950-2010.

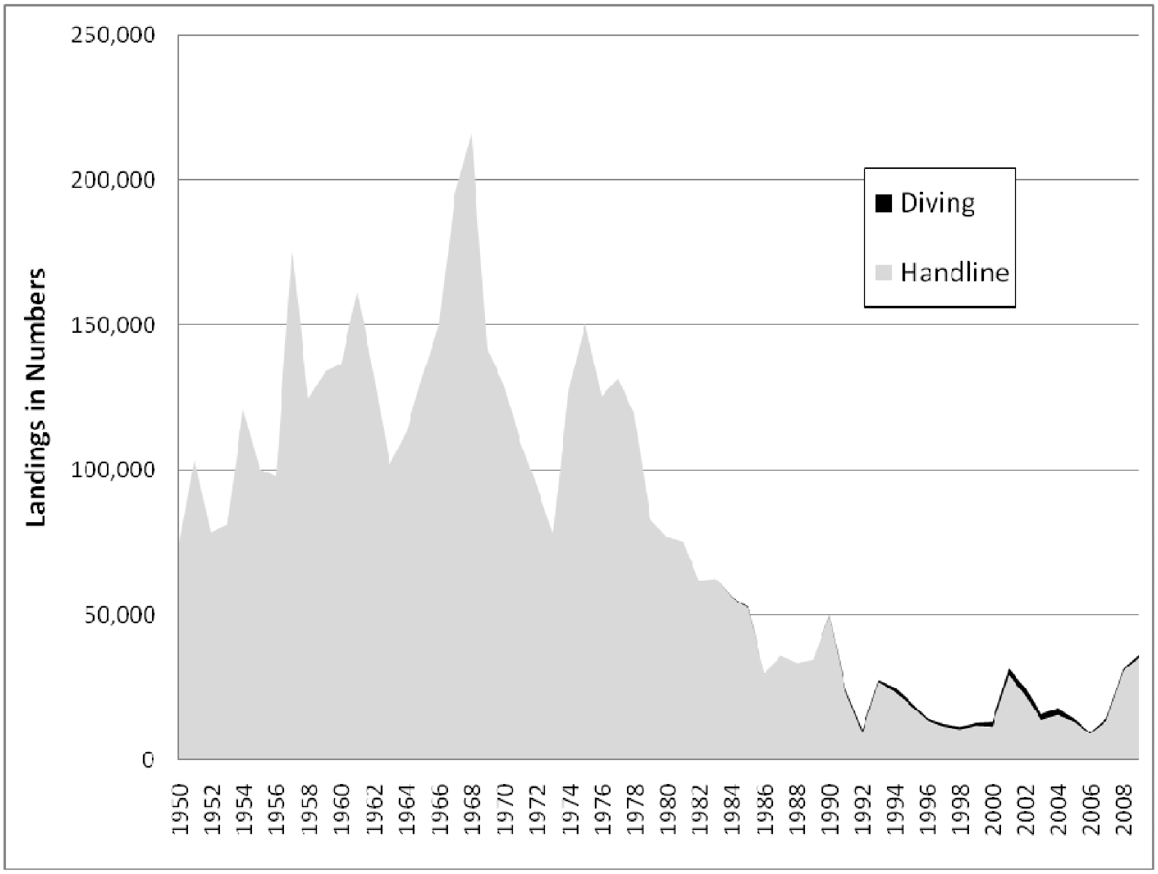


**Figure 3.10.** Length composition of discarded red snapper from handline gear based on observer data collected 2007-2009 (n = 145) (reference GSAFF 2008 for sampling details). [Converted from FL to TL based on TL-FL relationship in Section 2]

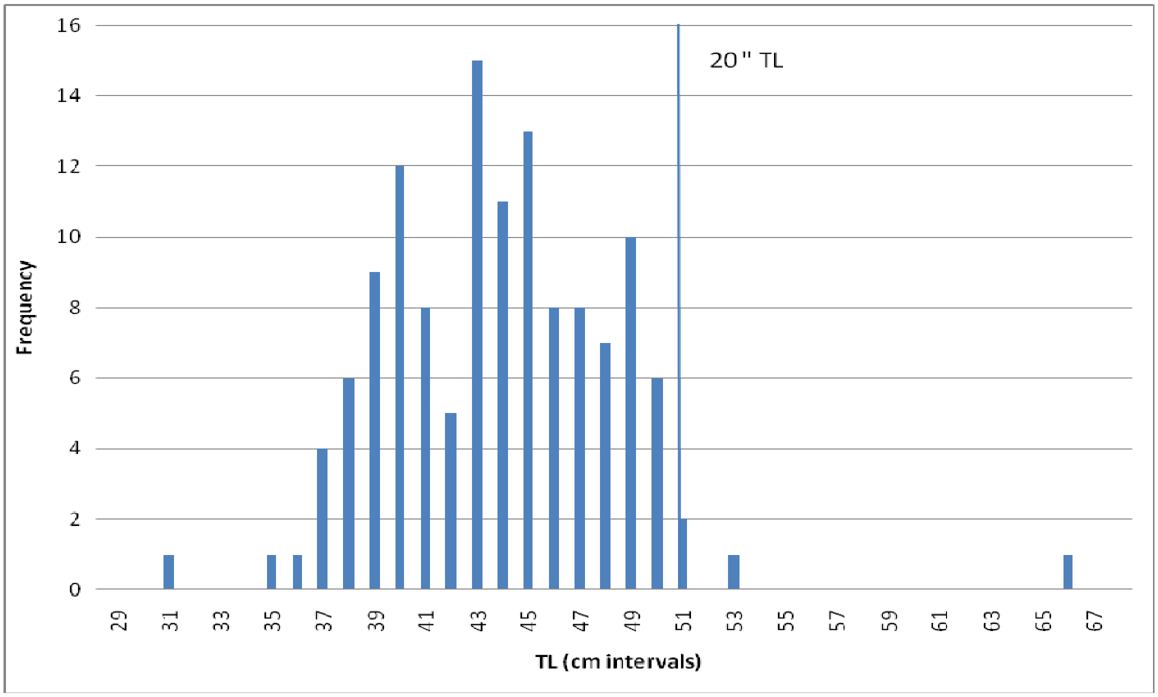



**Figure 3.11.** Comparison of logbook landings and observer discard depth profiles, combined with discard mortality estimates from Burns et al. Depth profile percentages are on left scale and mortality is on right scale. SA stands for South Atlantic logbook landings and Observer to discard fish.

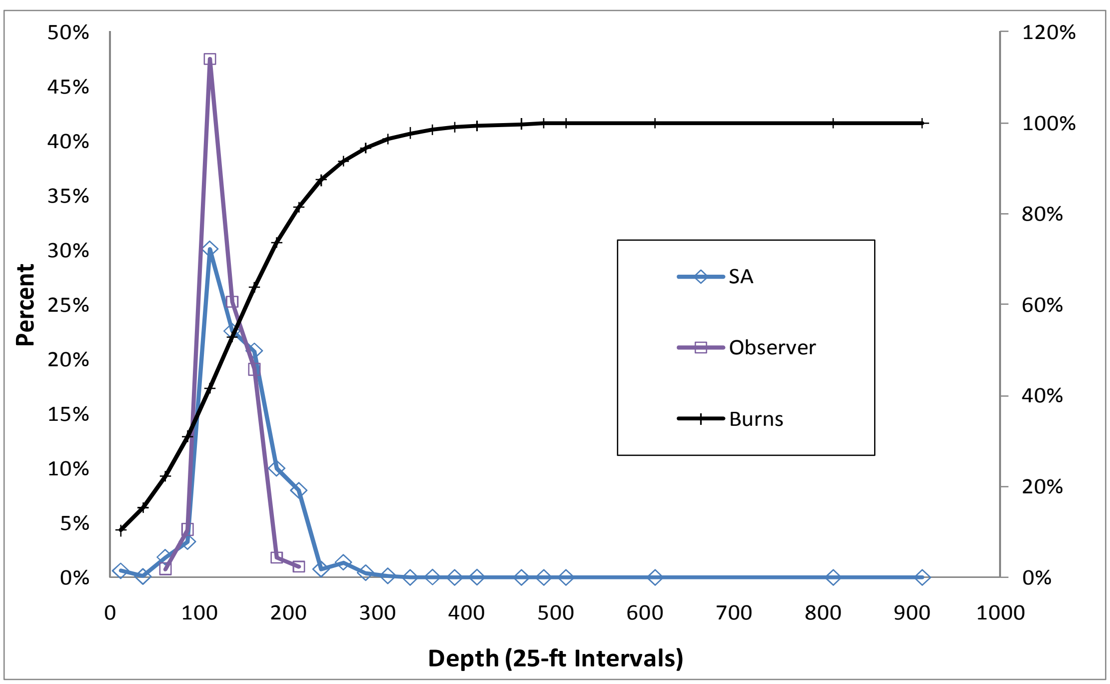


**Figure 3.12.** Annual length composition of red snapper for commercial handline from TIP, 1985-1986, 1989-2004, 2007, and 2009. Weighting based on landings and trip catch in numbers. Sample size and year are shown on each subplot.

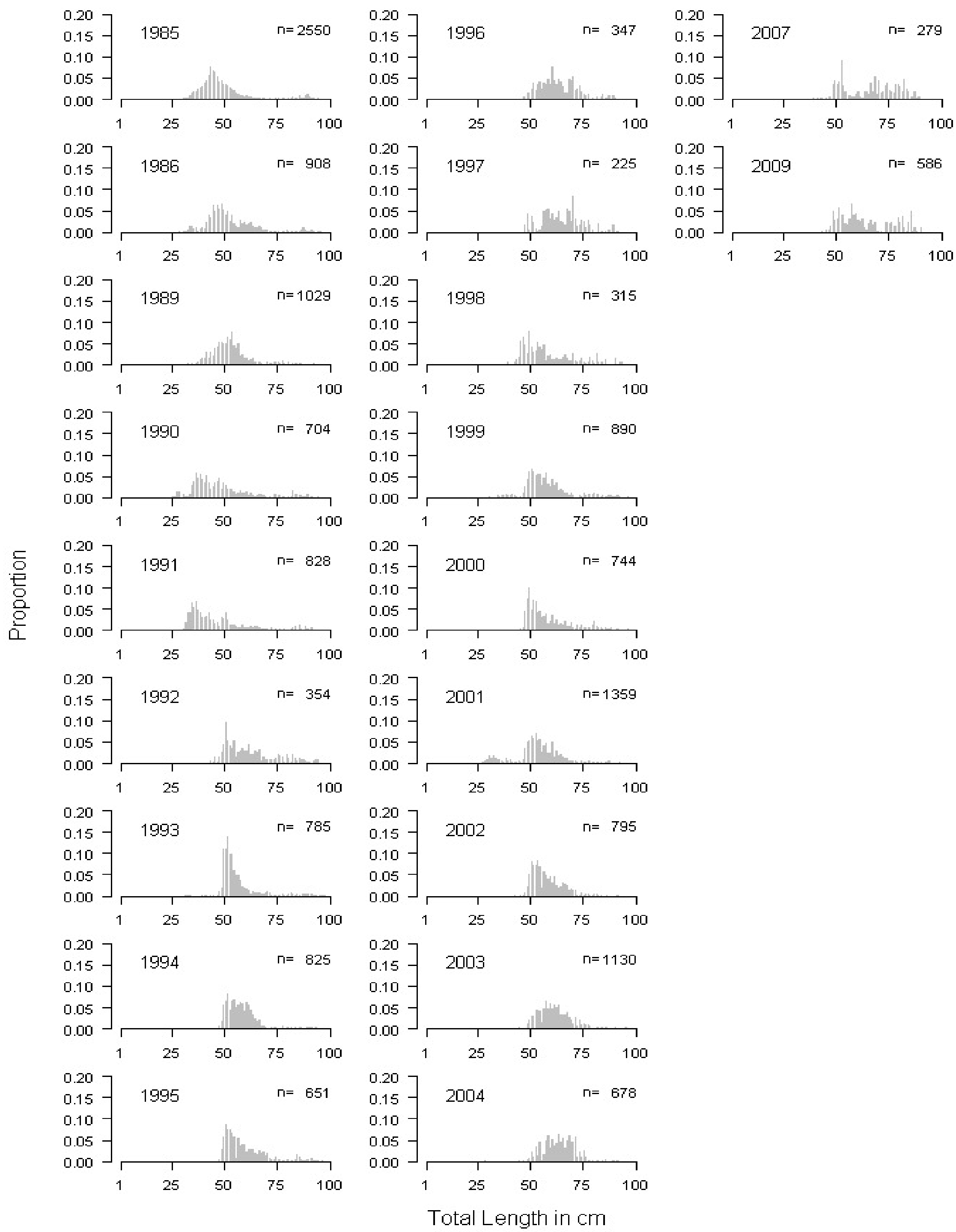


**Figure 3.13.** Annual length composition of red snapper for commercial diving from TIP, 1999-2001. 2003, and 2009. Weighting based on landings in numbers and trip catch in numbers. Sample size and year are shown on each subplot.

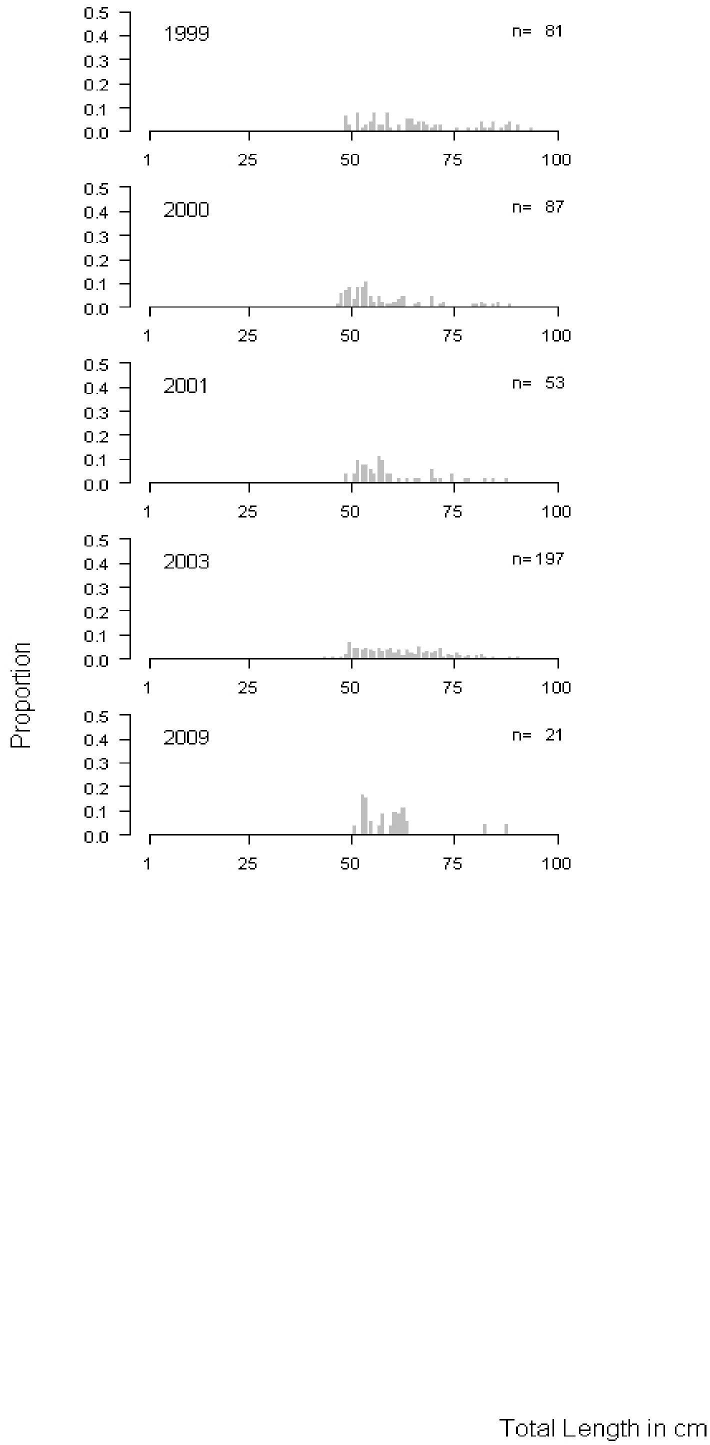


**Figure 3.14.** Age composition of red snapper for commercial handline from TIP, 1992, 1995-2009. Weighting based on corresponding length composition availability. Sample size and year are shown on each subplot.

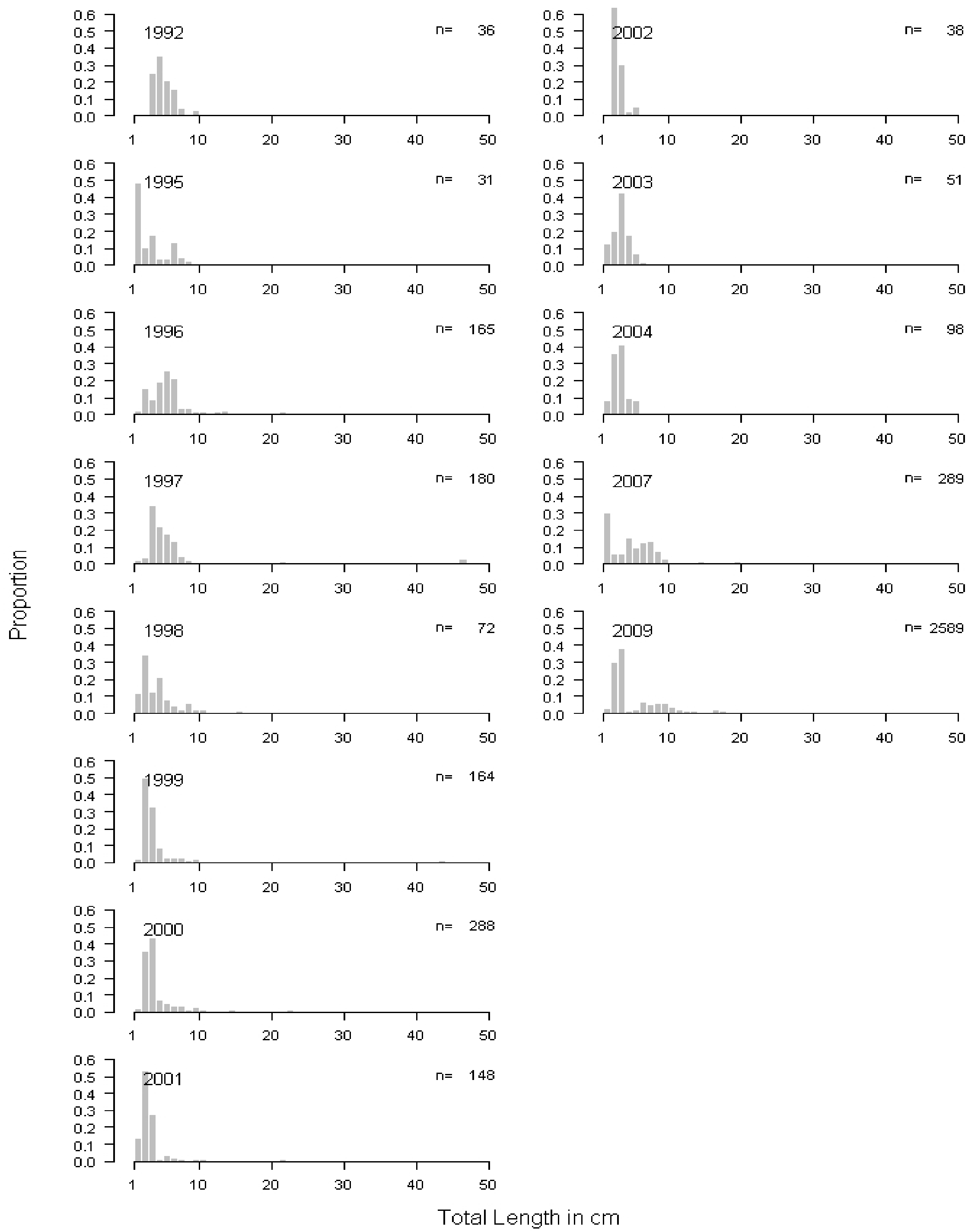


**Figure 3.15.** Age composition of red snapper for commercial diving from TIP, 2000-2001, and 2009. Weighting based on corresponding length composition availability. Sample size and year are shown on plots.

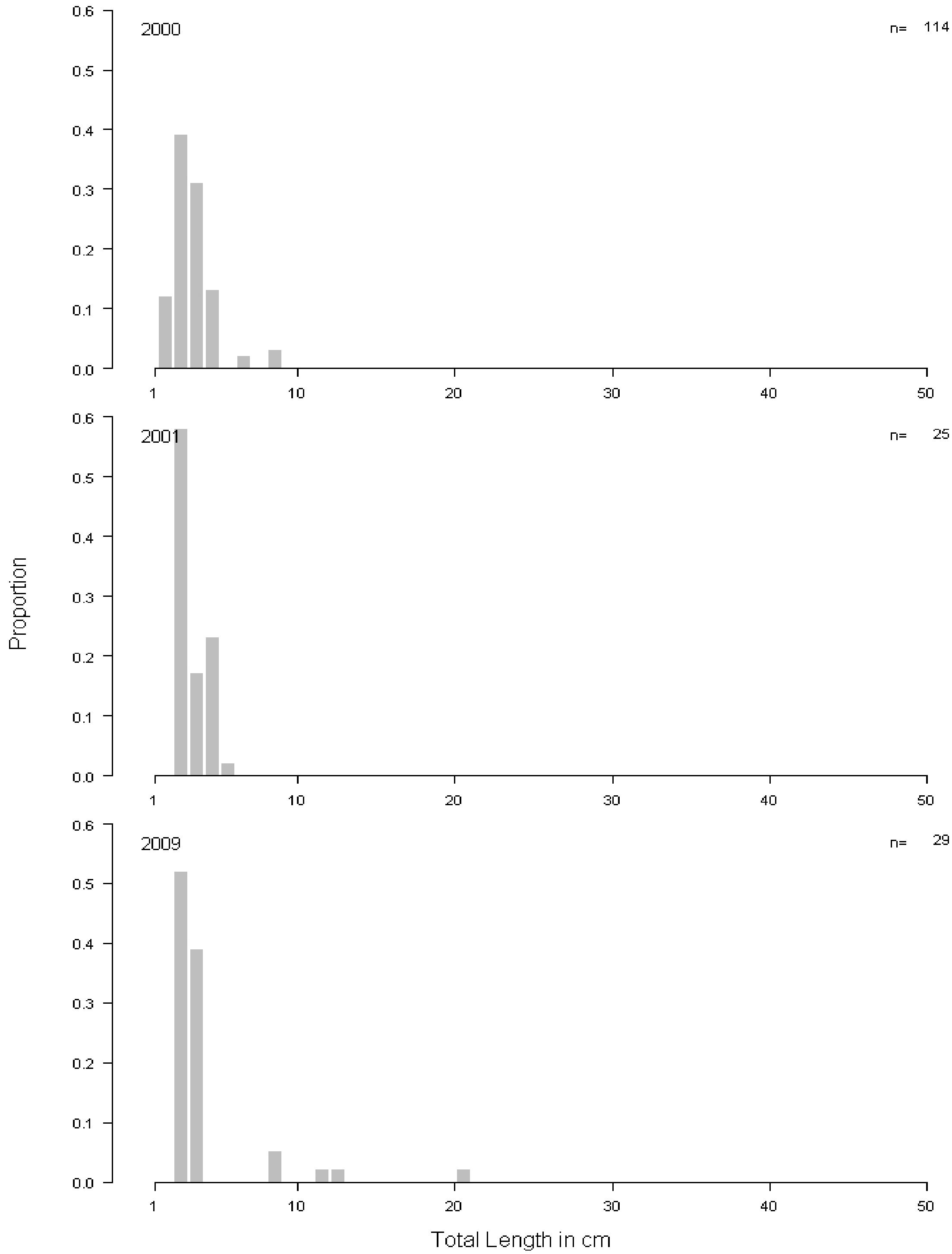
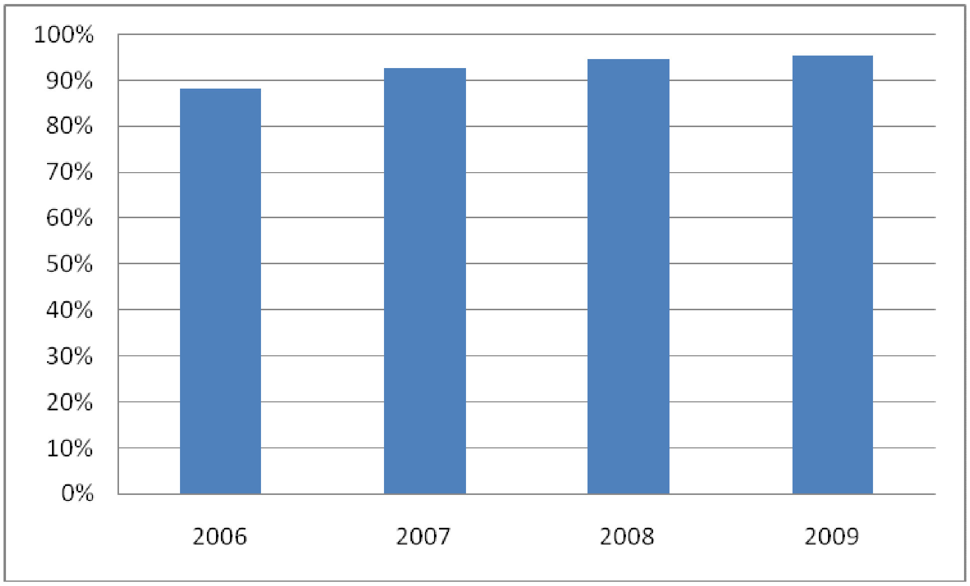


**Figure 3.16. Proportion of landings (a) and length samples (b) that are unsorted relative to market category.**

**(a) Landings (ALS data base)**




**(b) Length samples (TIP data base)**

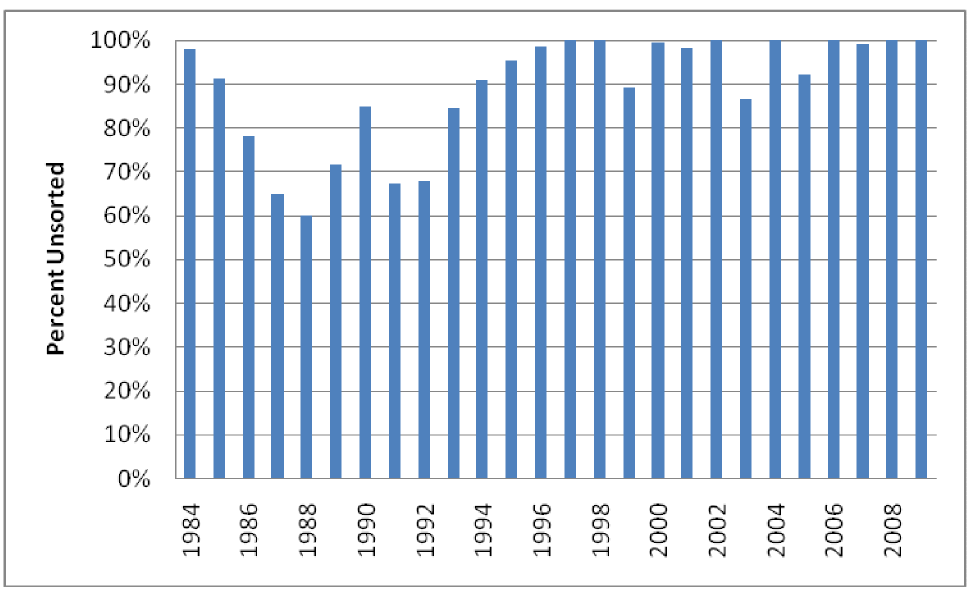
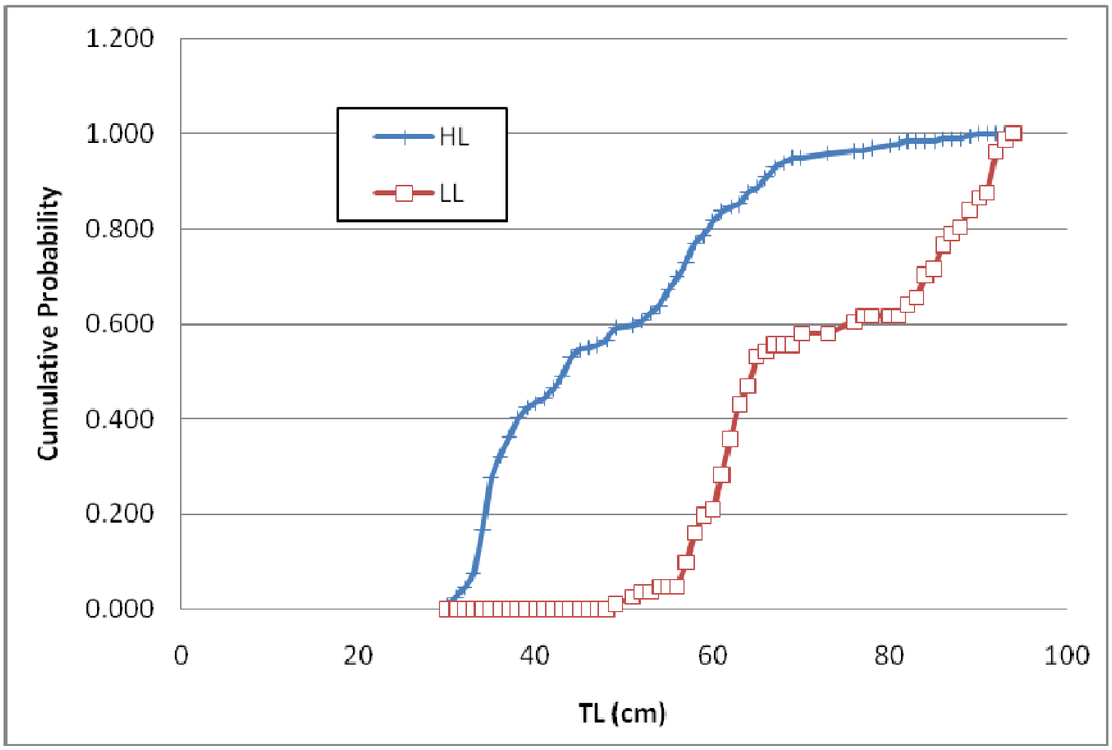


**Figure 3.17.** Direct comparison of cumulative probability (Pr(X<TL) for handline and longline lengths (TL, cm) from TIP based on limited samples from North Carolina in 1987. There were 81 fish lengths from longline and 277 fish lengths from handline. These data are treated as a random sample from this state-year cell, and no post-stratification weighting is applied.



## Addendum 3.1

================================================================

### Refer to Commercial Landings (Section 3.1)

### NMFS SEFIN Accumulated Landings (ALS)

Information on the quantity and value of seafood products caught by fishermen in the U.S. has been collected as early as the late1890s. Fairly serious collection activity began in the 1920s.

The data set maintained by the Southeast Fisheries Science Center (SEFSC) in the SEFIN data base management system is a continuous data set that begins in 1962.

In addition to the quantity and value, information on the gear used to catch the fish, the area where the fishing occurred and the distance from shore are also recorded. Because the quantity and value data are collected from seafood dealers, the information on gear and fishing location are estimated and added to the data by data collection specialists. In some states, this ancillary data are not available.

Commercial landings statistics have been collected and processed by various organizations during the 1962-to-present period that the SEFIN data set covers. During the 16 years from 1962 through

1978, these data were collected by port agents employed by the Federal government and stationed at major fishing ports in the southeast. The program was run from the Headquarters Office of the Bureau of Commercial Fisheries in Washington DC. Data collection procedures were established by Headquarters and the data were submitted to Washington for processing and computer storage. In 1978, the responsibility for collection and processing were transferred to the SEFSC.

In the early 1980s, the NMFS and the state fishery agencies within the Southeast began to develop a cooperative program for the collection and processing of commercial fisheries statistics. With the exception of two counties, one in Mississippi and one in Alabama, all of the general canvass statistics are collected by the fishery agency in the respective state and provided to the SEFSC under a comprehensive Cooperative Statistics Program (CSP).

The purpose of this documentation is to describe the current collection and processing procedures that are employed for the commercial fisheries statistics maintained in the SEFIN data base.

1960 - Late 1980s
================================================================

Although the data processing and data base management responsibility were transferred from the Headquarters in Washington DC to the SEFSC during this period, the data collection procedures remained essentially the same. Trained data collection personnel, referred to as fishery reporting specialists or port agents, were stationed at major fishing ports throughout the Southeast Region. The data collection procedures for commercial landings included two parts.

The primary task for the port agents was to visit all seafood dealers or fish houses within their assigned areas at least once a month to record the pounds and value for each species or product type that were purchased or handled by the dealer or fish house. The agents summed the landings and value data and submitted these data in monthly reports to their area supervisors. All of the monthly data were submitted in essentially the same form.

The second task was to estimate the quantity of fish that were caught by specific types of gear and the location of the fishing activity. Port agents provided this gear/area information for all of the landings data that they collected. The objective was to have gear and area information assigned to all monthly commercial landings data.

There are two problems with the commercial fishery statistics that were collected from seafood dealers. First, dealers do not always record the specific species that are caught and second, fish or shellfish are not always purchased at the same location where they are unloaded, i.e., landed.

Dealers have always recorded fishery products in ways that meet their needs, which sometimes make it ambiguous for scientific uses. Although the port agents can readily identify individual species, they usually were not at the fish house when fish were being unloaded and thus, could not observe and identify the fish.

The second problem is to identify where the fish were landed from the information recorded by the dealers on their sales receipts. The NMFS standard for fisheries statistics is to associate commercial statistics with the location where the product was first unloaded, i.e., landed, at a shore-based facility. Because some products are unloaded at a dock or fish house and purchased and transported to another dealer, the actual 'landing' location may not be apparent from the dealers' sales receipts. Historically, communications between individual port agents and the area supervisors were the primary source of information that was available to identify the actual unloading location.

Cooperative Statistics Program
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In the early 1980s, it became apparent that the collection of commercial fisheries statistics was an activity that was conducted by both the Federal government and individual state fishery agencies. Plans and negotiations were initiated to develop a program that would provide the fisheries statistics that are needed for management by both Federal and state agencies. By the mid- 1980s, formal cooperative agreements had been signed between the NMFS/SEFSC and each of the eight coastal states in the southeast, Puerto Rico and the US Virgin Islands.

Initially, the data collection procedures that were used by the states under the cooperative agreements were essentially the same as the historical NMFS procedures. As the states developed their data collection programs, many of them promulgated legislation that authorized their fishery agencies to collect fishery statistics. Many of the state statutes include mandatory data submission by seafood dealers.

Because the data collection procedures (regulations) are different for each state, the type and detail of data varies throughout the Region. The commercial landings data base maintained in SEFIN contains a standard set of data that is consistent for all states in the Region.

A description of the data collection procedures and associated data submission requirements for each state follows.

Florida
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Prior to 1986, commercial landings statistics were collected by a combination of monthly mail submissions and port agent visits. These procedures provided quantity and value, but did not provide information on gear, area or distance from shore. Because of the large number of dealers, port agents were not able to provide the gear, area and distance information for monthly data. This information, however, is provided for annual summaries of the quantity and value and known as the Florida Annual Canvas data (see below).

Beginning in 1986, mandatory reporting by all seafood dealers was implemented by the State of Florida. The State requires that a report (ticket) be completed and submitted to the State for every trip. Dealers have to report the type of gear as well as the quantity (pounds) purchased for each species. Information on the area of catch can also be provided on the tickets for individual trips. As of 1986 the ALS system relies solely on the Florida trip ticket data to create the ALS landings data for all species other than shrimp.

Georgia
===========================================================================

Prior to 1977, the National Marine Fisheries Service collected commercial landings data Georgia. From 1977 to 2001 state port agents visited dealers and docks to collect the information on a regular basis. Compliance was mandatory for the fishing industry. To collect more timely and accurate data, Georgia initiated a trip ticket program in 1999, but the program was not fully implemented to allow complete coverage until 2001. All sales of seafood products landed in Georgia must be recorded on a trip ticket at the time of the sale. Both the seafood dealer and the seafood harvester are responsible for insuring the ticket is completed in full

South Carolina

Prior to 1972, commercial landings data were collected by various federal fisheries agents based in South Carolina, either U.S. Fish or Wildlife or National Marine Fisheries Service personnel. In 1972, South Carolina began collecting landings data from coastal dealers in cooperation with federal agents. Mandatory monthly landings reports on forms supplied by the Department are required from all licensed wholesale dealers in South Carolina. Until fall of 2003, those reports were summaries collecting species, pounds landed, disposition (gutted or whole) and market category, gear type and area fished; since September 2003, landings have been reported by a mandatory trip ticket system collecting landings by species, disposition and market category, pounds landed, ex-vessel prices with associated effort data to include gear type and amount, time fished, area fished, vessel and fisherman information. South Carolina began collecting TIP length frequencies in 1983 as part of the Cooperative Statistics Program.

Target species and length quotas were supplied by NMFS and sampling targets of 10% of monthly commercial trips by gear were set to collect those species and length frequencies. In 2005, South Carolina began collecting age structures (otoliths) in addition to length frequencies, using ACCSP funding to supplement CSP funding.

North Carolina

The National Marine Fisheries Service prior to 1978 collected commercial landings data for North Carolina. Port agents would conduct monthly surveys of the state's major commercial seafood dealers to determine the commercial landings for the state. Starting in 1978, the North Carolina Division of Marine Fisheries entered into a cooperative program with the National Marine Fisheries Service to maintain the monthly surveys of North Carolina's major commercial seafood dealers and to obtain data from more dealers.

The North Carolina Division of Marine Fisheries Trip Ticket Program (NCTTP) began on 1 January 1994. The NCTTP was initiated due to a decrease in cooperation in reporting under the voluntary NMFS/North Carolina Cooperative Statistics Program in place prior to 1994, as well as an increase in demand for complete and accurate trip-level commercial harvest statistics by fisheries managers. The detailed data obtained through the NCTTP allows for the calculation of effort (i.e. trips, licenses, participants, vessels) in a given fishery that was not available prior to 1994 and provides a much more detailed record of North Carolina's seafood harvest.

**NMFS SEFIN Annual Canvas Data for Florida**

The Florida Annual Data files from 1976 – 1996 represent annual landings by county (from dealer reports) which are broken out on a percentage estimate by species, gear, area of capture, and distance from shore. These estimates are submitted by Port agents, which were assigned responsibility for the particular county, from interviews and discussions from dealers and fishermen collected throughout the year. The estimates are processed against the annual landings totals by county on a percentage basis to create the estimated proportions of catch by the gear, area and distance from shore. (The sum of percentages for a given Year, State, County, Species combination will equal 100.)

Area of capture considerations: ALS is considered to be a commercial landings data base which reports where the marine resource was landed. With the advent of some State trip ticket programs as the data source the definition is more loosely applied. As such one cannot assume reports from the ALS by State or county will accurately inform you of Gulf vs South Atlantic vs Foreign catch. To make that determination you must consider the area of capture.

# 4. Recreational Fishery Statistics

## 4.1 Overview

### 4.1 Group membership

Members- Ken Brennan (Leader\NMFS Beaufort), Kathy Knowlton (Rapporteur\GADNR), Steve Amick (SAFMC Appointee/Industry rep GA), Zack Bowman (SAFMC Appointee/Industry rep GA), Julia Byrd (SCDNR), Rob Cheshire (NMFS Beaufort), Richard Cody (FWRI), Greg DeBrango (SAFMC Appointee/Industry rep FL), Frank Hester (Industry Consultant), Rusty Hudson (SAFMC Appointee/Industry rep FL), Beverly Sauls (FWRI), Tom Sminkey (NMFS Silver Spring), Rodney Smith (SAFMC Appointee/Industry rep FL), Erik Williams (NMFS Beaufort), Chris Wilson (NCDNR).

### 4.1.2 Issues

(1) Red snapper Charter Boat Landings: 1986-2003 & 2004-2009, survey methods changed.

(2) Red snapper Party/Charter Landings: 1981-1985; headboat landings are used from the Southeast Region Headboat survey (SRHS) program so we must parse out the headboat from party/charter during period when MRFSS did not stratify.

(3) Headboat landings data available for SEDAR 24 from 1976 for GA/NEFL and 1978 for SEFL through 1980, that was not available for SEDAR 15.

(4) Estimating red snapper headboat landings from 1972 to 1976 or 1978 (date dependent on region) for periods of partial geographic coverage in the SRHS.

(5) Headboat discards prior to 2007.

(6) Usefulness of historical data sources such as the 1960, 1965, and 1970 U.S. Fish and Wildlife Service (FWS) surveys to generate estimates of recreational red snapper landings prior to 1972. Compare these sources to other historical data sources, including commercial landings and Florida Sport Fishing Association (FSFA) catch program.

(7) Uncertainty estimates for headboat landings and discards

(8) Methods for estimating for-hire effort in the MRFSS survey changed to the new For-Hire Survey (FHS) methodology in 2003. For SEDAR 24, there was sufficient overlap in the two time-series to adjust old MRFSS estimates for the new FHS methodology; whereas, only the old method could be used in SEDAR 15.

(9) MRFSS for-hire estimates for SC were highly variable and much higher in some years than the SC state logbook for charter vessels.

## 4.2 Review of Working Papers

***SEDAR24-DW06,*** *Distribution of red snapper catches from headboats operating in the South Atlantic. Erik Williams, Rob Cheshire and Ken Brennan.*

The Southeast Region Headboat Survey (SRHS) which collects trip level catch information through monthly logbook reporting was briefly discussed. Logbook reports provide a single location (10 $min^2$ grid) for all reported catch within each trip. Although logbooks are required for all head boats, compliance has varied over the years. Recent years have seen improvements in reporting in terms of fleet compliance and trip level information provided and although only 3% of reported trips in 2009 (compared to 26% in 2004) were either missing or had incomplete trip information, reporting bias remained a concern. In addition to catch from an entire trip being associated with a single location, the potential for misreporting location, under-reporting of discards, and a lack of discard information prior to 2007 were important considerations in the use of these data to characterize red snapper catch distribution. Trip length and physical location of the vessel provide an alternative to reported location and allows for characterization of red snapper catch distribution by inlet with respect to distance traveled, minimum species depth and maximum depth fished. Distributions are presented in SEDAR24-DW06, which was available for review.

***SEDAR24-DW07***, Georgia Headboat Red Snapper Catch & Effort Data, 1983-2009 Steve Amick and Kathy Knowlton.

This working paper presents detailed red snapper catch records from a GA headboat. The captain, Steve Amick, recorded his catch records in personal logbooks at the end of every fishing day, including number of released fish (a data element not available for headboats from the NMFS survey until 2004). Captain Amick offered to provide these data through a cooperative effort with personnel at the Georgia Department of Natural Resources for consideration at SEDAR24. Data elements included vessel name, trip type, number red snapper released alive, number red snapper harvested, number of anglers, and number of vessel trips. Throughout the time period (1983 through 2009), Captain Amick typically fished southeast of Savannah, GA at depths of 90-120 feet in the NMFS headboat survey grid 31-80. Combined, these data represent ~4,000 snapper-grouper fishing trips for which ~41,000 anglers caught ~46,000 and harvested ~21,000 red snapper. The RFWG accepted this working paper and data contained within for further detailed review.

***SEDAR24-DW11***, Estimation of Historic Recreational Landings 2010. Historical Fisheries Working Group.

The Terms of Reference (TOR) for the SEDAR 24 Data Workshop (DW) list as a product to "Review the application of pre-MRFSS recreational catch records in the SEDAR 15 benchmark assessment and recommend appropriate use of pre-MRFSS data for assessment of red snapper" (SEDAR24, DW TOR number 7). The Historic Fisheries Working Group (HFWG) was formed in advance of the SEDAR 24 Data Workshop to begin this task. A description of the analyses conducted by the HFWG is presented in SEDAR24-DW11 and the results of those analyses were reviewed by the Recreational Work Group (RWG).

The HFWG explored the following methods for generating estimates of historic recreational red snapper catches:

1) Ratio Method: Compares ratios of commercial red snapper landings in the South Atlantic to recreational red snapper harvest estimates for years in which both are available to perform back calculations of recreational landings.
2) Saltwater Angling Survey Method: U.S. Fish and Wildlife Saltwater Angling Surveys (SWAS) were conducted in 1960, 1965, and 1970. Neither the HFWG nor the RWG

recommended using these point estimates without accounting for species mis-identifications and probable over-estimations related to recall bias and survey design limitations.

3) Census Method: Use U.S. Census data as a proxy for recreational fishing effort to produce regression based estimates for red snapper catches. The HFWG did not recommend using this method without an abundance index to include in the regression model.
4) Historic Documentation: Developing a timeline for the development and growth of the recreational red snapper fisheries in the South Atlantic for comparison with estimates of historic landings. This timeline included valuable anchor points that were discussed extensively by the RWG and compared to back-calculated landings estimates for trends and magnitude.

Results using the ratio method and adjusted Saltwater Angling Survey estimates indicate that catches for red snapper were high in the 1970s, dropped to lower levels in the 1980s, decreased through the 1990s, and moderately increased during the 2000s. This also agrees with landings constructed by the Commercial Workgroup, which peaked in 1968. The HFWG also reviewed a dataset available online from a Florida sport fishing club that indicated a similar trend in recreational catches based on club records. The two trends also track well with the timeline for early development and growth of red snapper recreational fisheries in the South Atlantic. There was disagreement within the RWG on the magnitude of estimated landings. In particular, several participants felt that private recreational effort was not high enough to generate such a high peak in the estimated recreational landings in the 1970s. One method that was explored by the RWG was to account for exponential growth in the human population by scaling the ratio method using U.S. Census data. The ratio of commercial to private landings declined from 1980 to 1950 relative to the population. Scaled landings for the private sector were then interpolated to 0 in 1950 when it is generally accepted that private recreational fishing effort was very low. The result of this change reduced the slope and magnitude of peak landings for the private sector. RWG participants were in agreement that the for-hire sector was well developed in earlier years, and for-hire landings were not scaled to Census data or interpolated to 0 in 1950

***SEDAR24-DW13***, South Atlantic Red Snapper Marine Recreational Fishery Landings: FHS-conversion of Historic MRFSS Charterboat Catches, T. R. Sminkey, NMFS, ST1, Silver Spring, MD. 2009.

From 2004 to 2007, the NMFS estimated charter boat effort using both the MRFSS (old) and the For-Hire Survey (FHS = new) protocols. Thus, differences in effort estimates for each stratum between both methodologies can be directly compared only for that period of time. Each stratum is defined by a unique combination of sub-region, state, year, 'wave', and fishing-area, where a 'wave' is a bimonthly sampling period (Jan.-Feb. = wave 1). The MRFSS defined fishing areas for most states as: a) Inshore waters, b) ocean, state territorial seas (< 3 miles from shore), and c) ocean, EEZ (> 3 miles from shore). For the period 1986-2003, charter boat effort was estimated using only the MRFSS protocol. To calibrate MRFSS charter boat effort estimates (1986-2003) to FHS levels, conversion factors (ratios) between FHS and MRFSS charter boat effort were estimated using 2003-2007 data and applied to the 1986-2003 MRFSS effort estimates. To estimate the conversion factors, a ratio of FHS/MRFSS effort estimates was calculated for each stratum using only the estimates from the period 2003-2007. A generalized linear model (GLM procedure, SAS Inst.) was used to identify significant factors and to estimate predicted ratios.

The factors included in the model were year, wave, fishing area, state and the interaction terms. In the event that a factor was found non-significant ($Pr > 0.05$), it was removed and the regression re-run until all (highest order) model terms were significant. The predicted ratios were used as the conversion factors to produce an adjusted time series of charter boat angler effort, and subsequently, catches.

***SEDAR24-DW15***, Red Snapper Length Frequencies and Condition of Released Fish from At-Sea Headboat Observer Surveys, 2004 to 2009. B. Sauls and C. Wilson 2010.

From 2004 to 2009, headboats in South Carolina and North Carolina participated in an at-sea observer survey. From 2005 to 2009, headboats along the Atlantic coast of Florida and Georgia also participated in an at-sea observer survey. The purpose of the Headboat At-Sea Survey was to collect detailed information on both harvested and discarded fish during recreational fishing trips on board working headboats. This report is a summary of information collected on the size, release condition, and final disposition of red snapper collected by trained observers during at-sea surveys on board headboats. While this information is specific to the recreational headboat fishery, it provides valuable information on the size of discarded fish from the recreational fishery, which historically has not been collected in other surveys of recreational fishing.

## 4.3 Recreational Landings

### 4.3.1 Marine Recreational Fisheries Statistics Survey (MRFSS)

*Introduction*

The Marine Recreational Fisheries Statistics Survey (MRFSS) provides a long time series of estimated catch per unit effort, total effort, landings, and discards for six two-month periods (waves) each year. The survey provides estimates for three recreational fishing modes: shore-based fishing (SH), private and rental boat fishing (PR), and for-hire charter and guide fishing (CH). When the survey first began in Wave 2 (Mar/Apr), 1981, head boats were included in the for-hire mode, but were excluded after 1985 to avoid overlap with the Head boat Logbook Survey conducted by the NMFS Beaufort, NC lab.

The MRFSS survey covers coastal Atlantic states from Maine to Florida. The state of Florida is sampled independently as two sub-regions. The east Florida sub-region includes counties adjacent to the Atlantic coast from Nassau County south through Miami-Dade County, and the west Florida sub-region includes Monroe County (Florida Keys) and counties adjacent to the Gulf of Mexico (Collier-Escambia). Separate estimates are generated for each Florida sub-region, and those estimates may be post-stratified into smaller regions based on proportional sampling. With the exception of North Carolina, since 2006, sampling has not been conducted on the Atlantic coast, north of Florida in Wave 1 (Jan/Feb) because fishing effort is very low or non-existent.

The MRFSS design incorporates three complementary survey methods for estimating catch and effort. Catch data are collected through dockside angler intercept surveys of completed, recreational fishing trips. Effort data are collected using two telephone surveys. The Coastal Household Telephone Survey (CHTS) uses random digit dialing of coastal households to obtain from anglers detailed information about the previous two months of recreational fishing trips. The weekly For-Hire Survey interviews Charter boat operators (captains or owners) to obtain the trip information with a one-week recall period. These effort data and estimates are aggregated to produce the wave estimates. Catch rates from dockside intercept surveys are combined with estimates of effort from telephone interviews to estimate total landings and discards by wave, mode, and area fished (inland, state, and federal waters). Catch estimates from early years of the survey are highly variable with high percent standard errors (PSE's), and sample sizes in the dockside intercept portion have been increased over time to improve precision of catch estimates. Full survey documentation and ongoing efforts to review and improve survey methods are available on the NOAA Fisheries Office of Science and Technology website at: http://www.st.nmfs.gov/st1/recreational.

*New For-Hire Survey Methodology*

Survey methods for the for-hire fishing mode have seen the most improvement over time. Catch data were improved through increased sample quotas and state add-ons to the intercept portion of the survey. It was also recognized that CHTS intercepts for for-hire anglers were sporadic, and sample sizes were low. As a result, the For-Hire Telephone Survey (FHS) was developed to estimate effort in the for-hire mode. The new method draws a random sample of known for-hire charter and guide vessels each week and vessel operators are called and asked directly to report their fishing activity. The FHS was piloted in east Florida in 2000 and officially adopted in all the Atlantic coast states in 2003. A further improvement in the FHS method was the stratification of Florida into smaller sub-regions for estimating for-hire effort. The FHS sub-regions include three distinct regions bordering the Atlantic coast: Monroe County (sub-region 3), southeast Florida from Dade through Indian River Counties (sub-region 4), and northeast Florida from Brevard through Nassau Counties (sub-region 5). The coastal household telephone survey method for the for-hire fishing mode continues to run concurrently with new FHS method.

The recreational statistics workgroup of SEDAR 15 recommended a comparison of the two methods of estimation of charter boat effort be conducted so that CHTS estimates from earlier years can be adjusted and the new FHS estimates used for later years. This comparison was made at SEDAR 16 (DW-15, Sminkey, 2008) and applied to South Atlantic charter boat effort and king mackerel catches. The same conversion ratios were used in this data workshop to produce a time series of adjusted charter boat landings and live discards of red snapper (SEDAR 24- DW13, Sminkey 2010, Tables 4.1a, 4.1b, 4.2).

*Missing cells in MRFSS estimates*

The MRFSS calculates estimated landings in numbers and weight for each year, fishing mode, state, wave, and area fished (inshore, state waters, federal waters) combination, and each combination is referred to as a cell. Landings by weight are calculated by multiplying the average weight for all fish in a given cell by the estimated number of fish in the same cell. When no fish are weighed in a given cell, the estimated weight of fish landed is not generated for that cell. When there is an estimated number of fish landed, but no corresponding estimate for weight, that cell is referred to as a "missing cell". It is inappropriate to add cells together when there are missing weight estimates; therefore, weight estimates were filled in for missing cells by pooling cells and applying a pooled average weight to the number of fish in the cell with missing estimated weight. Weight landings were substituted in cells (Sub-reg, St, Year, Wave, Mode_fx, Area_x) that did not have >1 fish weighed. Average weight from sampled fish was calculated at the state or sub-region within the sampled wave and applied to the number sampled for those cells that lacked sufficient sampled weights. The new weight estimates were substituted and included in the annual weight estimates for red snapper. For the 1981 to 2009 time series, there were only four cells with missing mean weights (no substitution at state or sub-region level) in the private/rental boat mode, so annual mean weights for the sub-region were substituted and the wave weight landings were estimated. For the for-hire modes (PC in 1981-1985 and CH for 1986-2009) the landed weights were estimated from the modeled number landings using annual mean weights from observed data for the sub-region.

Wave 1 estimates were not generated from Virginia to Georgia due to low fishing activity during January and February. In east Florida, no landings estimates are available for Wave 1, except the first year of the time series in 1981. Wave 1 estimates for 1981 for Florida were generated for A+B1 and B2 catch for red snapper using the average Wave 1 portions of annual catch estimates for the 1980s. The 1981 annual landings were increased by the mean value that Wave 1 contributed during that decade.

*Shore Estimates*

Because red snapper is an offshore species with a strong association with reefs and hard bottom, the group felt that this species would not be landed from shore. Therefore, shore landings for red snapper were omitted from total landings estimates. Several species of nearshore fish are often referred to as "red snapper" by anglers, which may explain the infrequent red snapper shore landing estimates in the MRFSS time series.

*Monroe County*

Monroe county landings estimates from the MRFSS are included in the total landings for the Gulf of Mexico. While Monroe County landings can be post-stratified, they cannot be partitioned into fish from waters of the Atlantic Ocean or Gulf of Mexico. Because red snapper are less common on the extreme south Atlantic coast of Florida, Atlantic Coast landings from Monroe County likely contribute only a very small amount to recreational red snapper landings from the Atlantic. Because Gulf of Mexico red snapper could not be partitioned out of the Monroe County landings, the recreational workgroup decided not to include Monroe County MRFSS estimates. Head boat landings from Monroe County are separated by area fished, and trips that occurred on the Atlantic side of Keys and Dry Tortugas were included in head boat landings.

### 4.3.2 Southeast Region Headboat Survey (SRHS)

*Introduction*

The Southeast Region Headboat Survey estimates landings and effort for headboats in the South Atlantic and Gulf of Mexico. To determine red snapper landings estimates for the earliest possible year, the recreational working group first considered the areas of coverage in the early years of the Survey. The Headboat Survey was started in 1972 but only included vessels from North Carolina and South Carolina until 1975. In 1976 the survey was expanded to northeast Florida (Nassau-Indian River counties) and Georgia, followed by southeast Florida (St. Lucie-Monroe counties) in 1978. Red snapper landings estimates in the South Atlantic are only available for those years when coverage occurred.

Headboat data prior to 1981, not available for SEDAR 15, were considered for inclusion for SEDAR 24. Based on data tabulated on paper copies and recently key-entered, these data included estimated red snapper landings from 1976-1980 for GA/NEFL and 1978-1980 for SEFL. These data were verified with previous Headboat Survey personnel as having been collected during those time periods. NC and SC landings already key-entered and used in SEDAR15 were compared and matched to the hard copies of the recovered tabulated data for the time period 1972-1980 to check for accuracy. These updated estimates are highlighted in Table 4.3.

*Issue 1: Headboat landings data available for SEDAR 24 from 1976 for GA/NEFL and 1978 for SEFL through 1980 that were not available for SEDAR 15.*

Option 1: Include the new data in the assessment in place of the estimates used in the previous assessment.

Option 2: Do not include the new data in the assessment in place of the estimates used in the previous assessment.

**Decision:** Option 1 to include the newly key-entered data for 1976 for GA/NEFL and 1978 for SEFL through 1980.

*Issue 2: The Headboat Survey had partial geographic coverage. Reported data are not available for GA/NEFL from 1972-1975 or SEFL from 1972-1977.*

Estimates for these area/time periods can be calculated from several methods using the ratio of NC and SC landings from 1972-1977 for periods of partial coverage. Three and five year averages were used to estimate landings for the areas and time periods without coverage. After comparing both methods, the RWG concluded the three year average was less likely to mask real annual variability. These ratios were compared in Table 4.4.

Option 1: Three-year average ratio of NC & SC

Option 2: Five-year average ratio of NC & SC

Option 3: 1972-1980 ratio of NC & SC (used in SEDAR15)

**Decision:** Option 1 for estimating both number and weight to predict landings for GA/EFL 1972-1975 and SEFL for 1972-1977.

Based on this decision the 3 year average ratio was applied to the areas and periods when partial coverage occurred. The complete time series of red snapper estimated headboat landings from 1972-2009 are summarized in Table 4.5.

### 4.3.3 Historic Recreational Landings

*Introduction*

The historic recreational catch time period will be defined as pre-1981 for the charter and private boat sectors, which represents the start of the Marine Recreational Fisheries Statistics Survey (MRFSS). The headboat data in the South Atlantic for red snapper has been extended back in time to 1972, which represents the beginning of Southeast Region Headboat Survey. Therefore the historic period for the headboat sector is pre-1972.

During the SEDAR 24 data workshop the RWG reviewed the working paper on historical recreational red snapper catches (SEDAR24-DW11). It was agreed at the workshop that the preferred method for filling in the historic recreational catch would be to use the ratio of recreational to commercial catches in numbers (with the private sector scaled to US Census data, see Section 4.2 for discussion). This choice was based in part on the ability to split the historical catch into for-hire and private boat modes. It is also a continuous series of data points, whereas the SWAS produce estimates for only three years. Within the ratio method, concerns over species misidentification are far less likely when based on commercial landings, as opposed to the SWAS. The large adjustment factors necessary for estimating red snapper landings using the SWAS data points caused a great deal of concern among participants. However, the RWG recommends that the adjusted SWAS historical landings be included in a sensitivity run. At that point, the two methods could be further reviewed. The RWG agreed that only the numbers of fish should be extended back in time because of uncertainty in average weights of fish landed in the recreational sector in the historic time period.

*Ratio method*

Following the rationale laid out in the historic recreational landings working paper (SEDAR24-DW11), the years pre-1992 were used for computing the average ratio between recreational and commercial landings. It was also agreed at the data workshop that a reasonable representation of the uncertainty could be obtained by using the minimum and maximum ratio values to represent confidence bounds. Further detail on the justification and other analyses for using the ratio method are provided in the historic recreational landings working paper (SEDAR24-DW11). It should be noted that most of the catch times series used in SEDAR24-DW11 have been updated and the values contained in that working paper should not be used as actual catch estimates.

For the for-hire sector (headboat and charter boat combined) the average ratio was assumed constant for all years back to 1950, the earliest year of data provided by the commercial working group. There was considerable debate at the data workshop about how to extend the private boat landings back in time. The SEDAR24-DW11 working paper assumed a linear decline to zero in 1950 in the private boat to commercial ratio. The RWG agreed that it was likely near zero in 1950. However, there was concern among some participants about the apparent peak in 1968 in private boat landings. The timeline in SEDAR24-DW11 suggested that private boats, in particular fiberglass boats, did not begin rapid expansion until the early 1970s. In part to accommodate this concern, the RWG decided to make the declining ratio of private boat to commercial from 1980 to 1950 follow the human population trends in Northeast Florida and Georgia (from US Census data) for those same years. The effect of this ratio trend was to reduce the landings in the 1950s and 1960s relative to the linear declining ratio estimated landings so that the peak for the private landings occurs in the mid-1970s.

The final ratio statistics are shown in Table 4.6 and clearly indicate that the recreational sector is more than double the commercial catch. There is considerable variability in the ratio estimates as seen in the range of values. It is recommended that the assessment workshop consider using the minimum and maximum ratios applied to the commercial catch time series to represent the range of uncertainty in these historic recreational catch time series. The estimated landings of red snapper in numbers from the recreational sectors and the potential range of values are indicated in Figure 4.1a and Tables 4.7 and 4.8.

*Saltwater Angling Surveys (SWAS)*

The recreational working group recommended the USFWS saltwater angling survey estimates be adjusted and used in a sensitivity run of the red snapper stock assessment model. The details of the adjustments made to these estimates are discussed in SEDAR24-DW11. The resulting estimates for use in the stock assessment model are listed in Table 4.9. A comparison of the estimated historic recreational landings from both the ratio method and adjusted SWAS are presented in Figure 4.12.1b.

### 4.3.4 Additional Potential Data Sources

#### 4.3.4.1 SCDNR Charterboat Logbook Program Data, 1993 – 2009

*Introduction*

SCDNR issues three types of charter vessel licenses: V1 (vessels carrying six or fewer passengers), V2 (vessels carrying 7 to 49 passengers), and V3 (vessels carrying 50 or more passengers). In 1993, SCDNR's Marine Resources Division (MRD) initiated a mandatory logbook reporting system for all charter vessels to collect basic catch and effort data. Under state law, vessel owners/operators purchasing South Carolina Charter Vessel Licenses (V1, V2, or V3) and carrying fishermen on a for-hire basis are required to submit trip level reports of their fishing activity in waters off of SC. Logbook reports are submitted by mail or fax to the SCDNR Fisheries Statistics section monthly. Compliance is tracked by staff and charter vessel owners/operators failing to submit reports can be charged with a misdemeanor. The charter boat logbook program is a complete census and should theoretically represent the total catch and effort of the charter boat trips in waters off of SC.

Logbook Data:

The charter logbook reports include: date, number of fishermen, fishing locale (inshore, 0-3 miles, >3miles), fishing location (based on a 10x10 mile grid map), fishing method, hours fished, target species, and catch (number of landed and released fish by species) per vessel per trip. The logbook forms have remained similar throughout the program's existence with a few exceptions: in 1999 the logbooks forms were altered to begin collecting the number of fish released alive and the number of fish released dead (prior to 1999 only the total number of fish released were recorded) and in 2008 additional fishing methods were added to the logbook forms (including 4) cast, 5) cast and bottom, and 6) gig).

After being tracked for compliance each V1 charter boat log book report is coded and key entered into an existing Access database. (V2 and V3 charter boat logbook reports are tracked for compliance but are currently not coded and entered electronically.) Since the inception of the program, a variety of staff have coded the charterboat log book data. From ~1999 to 2006, only information that was explicitly filled out by the charterboat owners/operators on the logbook forms was coded and entered into the database. No efforts were made to fill in incomplete reports. From 2007 to the present, staff have tried to fill in incomplete trips reports through conversations with charterboat owners/operators and by making assumptions based on the submitted data (i.e. if a location description was given instead of a grid location – a grid location was determined, if fishing method was left blank – it was determined based on catch, etc.). From 1999 to 2006 each individual trip record was reviewed to look for anomalies in the data. Starting in 2007 queries were used to look for and correct anomalous data and staff began checking a component of the database records against the raw logbook reports. Coding and QA/QC measures prior to 1999 were likely similar to those used from 1999 to the present. However, details on these procedures were not available since staff members working on this project prior to 1998 are no longer with the SCDNR. Data are not validated and currently no correction factors are used to account for reporting errors. Recall periods for logbook records are typically one month or less – however can potentially be up to a year for delinquent charter boat licensees.

Data Summary:

SCDNR logbook vessel trips represent snapper grouper fishing trips where at least one of a suite of bottom fishes (likely, or even possibly, to occur in association with red snapper) were caught.

Trips that were combination of trolling and bottom fishing were included. These logbook data represent 15,260 fishing trips in which 65,215 anglers caught 10,114 red snapper and harvested 4,368 red snapper.

Table 4.10. presents measures of angler, trip, and catch statistics for each year from 1993 – 2009.

- Vessel trips – total number of trips where at least one of a suite of bottom fishes (likely, or even possibly, to occur in association with red snapper) was caught; includes both nearshore and offshore trips
- Average number of anglers per vessel trip – sum of the total number of anglers divided by the sum of the total vessel trips.
- Total catch per angler trip – sum of total number of red snapper caught divided by sum of total number of anglers (Figure 4.2).
- Total harvest per angler trip – sum of total number of red snapper harvested divided by the sum of total number of anglers (Figure 4.2).
- % released – sum of total number of red snapper released divided by the sum of the total of red snapper caught (Figure 4.3).
- % vessel trips with catch – sum of total number of vessel trips with at least one red snapper caught (released or harvested) divided by the sum of the total number of vessel trips (Figure 4.4).

SCDNR charter boat logbook data were compared with MRFSS charter boat estimates. Large scale differences were seen in total catch, with the SCDNR charter boat logbook catch being orders of magnitude smaller than MRFSS estimates, particularly in 1997 and 1999. These datasets were also compared to the NMFS headboat logbook estimates which were found to be similar in magnitude to SCDNR's charter boat logbook estimates (Figure 4.5). The RWG considered using the SCDNR charter logbook estimates, but decided not to substitute SC logbook data for MRFSS charter boat estimates in SC since there was no valid basis to indicate MRFSS estimates were incorrect.

#### 4.3.4.2 SCDNR State Finfish Survey (SFS)

The collection of finfish intercept data in South Carolina was conducted through a non-random intercept survey at public boat landings along the SC coast. The survey focuses on known productive sample sites and was conducted during January through December using a questionnaire and interview procedure similar to those of MRFSS. Implemented in 1989, the State Finfish Survey (SFS) was designed to address specific data gaps, within the MRFSS, as identified by SCDNR staff. These data gaps included the lack of length data from species of concern to the SCDNR and the lack of seasonal and area-specific catch frequencies. Another concern was the lack of catch and effort data from private boat anglers, which make up a majority of the angling trips in South Carolina coastal waters. These data gaps were initially addressed by interviewing inshore anglers targeting red drum and spotted seatrout at specific sample locations. Since 2002, more emphasis has been placed on acquiring length data from all finfish retained by anglers, canvassing at additional sampling locations, and interviewing all private fishing boats within all SC coastal areas. Broadening the scope of the survey may decrease some of the bias associated with the previous SFS protocol, which could potentially allow for better catch estimates and length frequency data.

During the period 1989-2009 a total of 182 red snapper were caught by fishing parties interviewed through the SFS survey. Of those fish, a total of 108 were harvested and 82 length measurements were obtained.) Based on the small sample size and the fact this survey does not typically interview offshore anglers, it was the decision of the RWG that this data set should not be used in recreational catch estimates for SEDAR 24.

#### 4.3.4.3 South Carolina's Angler-based Tagging Program

Since 1974, the South Carolina Marine Resources Division's Office of Fisheries Management has operated a tagging program that utilizes recreational anglers as a means for deploying external tags in marine game fish. The angler-based tagging program has proven to be a useful tool for promoting the conservation of marine game fish and increasing public resource awareness. In addition, the program has provided biologists with valuable data on movement and migration rates between stocks, growth rates, habitat utilization, and mortality associated with both fishing and natural events.

Select marine finfish species are targeted for tag and release based on their importance both recreationally and commercially to the State and South Atlantic region. The list of target species is further narrowed down based on the amount of historical data on that species with regards to seasonal movements, habitat requirements, growth rates and release mortality. Although red drum constitutes the majority of fish tagged and released by recreational anglers, program participants are encouraged to tag other eligible species where data gaps may exist. The South Carolina angler based tagging program will occasionally utilize volunteers that tag and release fish in waters other than SC, but is limited to only those anglers fishing offshore waters in the South Atlantic. These individuals usually are the most experienced in a particular fishery for which a directed tag and release effort is needed, and as is the case with red snapper tagging, a Florida based charter captain proved to be the most qualified to provide information on his fishing activity.

During 1991 to 2009, 1,644 red snapper were tagged and 181 recoveries were reported (Table 4.11). Median days at large were 170 days and ranged from 0 to 2,239 days. Twenty seven percent of red snapper recaptures were fish tagged off Sebastian Inlet, Florida, and recaptured in the same general area. However, between 1996 and 2002, there were 7 reported recaptures of red snapper off Cape Canaveral, FL that had initially been tagged off Sebastian Inlet, FL; a distance traveled of approximately 68 miles. Most location information included with the initial tag events and subsequent recaptures is not detailed making it difficult to determine exact fishing location and to track red snapper movements. When available, fishing depth and condition of released fish will be reviewed for all red snapper recaptures to assist with discard mortality estimates.

#### 4.3.4.4 GADNR Marine Sportfish Carcass Recovery Program

Since 1997, the GADNR has conducted the Marine Sportfish Carcass Recovery Project.

Rather than discarding, anglers place filleted fish carcasses in chest freezers located at participating marinas. Chest freezers are placed near the fish cleaning stations at selected locations along the Georgia coast. Each freezer is marked with an identifying sign and a list of target fish species. Inside the freezer is a supply of plastic bags, information cards, and pens. Cooperating anglers can place the filleted carcasses, with head and tail intact, in a bag, drop in a completed angler information card, and then place the bag in the freezer. Since 1997 the number of red snapper donated to the carcass program has been insignificant. Designed to target inshore species, the top species are usually red drum, spotted seatrout and southern kingfish. The RWG was in agreement that this data set should not be used in recreational catch estimates for SEDAR 24.

#### 4.3.4.5 SCDNR Fish Rack Recycling Program

Since 1996, the SCDNR has conducted the Fish Rack Recycling Program. Rather than discarding, anglers place filleted fish carcasses in freezers maintained at participating marinas, public boat landings, and private fishing clubs. The majority of freezers are placed within the Charleston area; however in the past freezers have been placed throughout coastal South Carolina. Cooperating anglers place the filleted carcasses, with head and tail intact, in a bag, with catch information (when, how, and where the fish were caught) in the freezer. Racks are collected monthly from the freezers and brought back to the lab for analysis. Cooperating anglers are asked to target five species: speckled sea trout, red drum, black drum, southern flounder and sheepshead. Since 1996 the number of red snapper donated to the Fish Rack Recycling Program has been insignificant. The RWG was in agreement that this data set should not be used in recreational catch estimates for SEDAR 24.

## 4.4 Recreational Discards

### 4.4.1 MRFSS discards

Discarded live fish (both number of fish and disposition are reported by the anglers interviewed in the MRFSS dockside intercept survey. The recall period for self-reported discard data is the day the fishing trip ended. Length and/or weight are unknown for all modes of fishing covered by the MRFSS in the South Atlantic sub-region. All live released fish statistics (B2 fish) in charter or party/charter mode were adjusted in the same manner as the landings (described in Section 4.2; SEDAR24-DW13). Size or weight of discarded fishes is not estimated in the MRFSS. At-sea sampling of headboat discards was initiated (NC/SC in 2004, GA/FL in 2005) as part of the improved for-hire surveys to characterize the size distribution of live discarded fishes in the headboat fishery.

Annual numbers of red snapper discards varied greatly in the 1980s, peaking for the for-hire sector in 1984 with more than 100,000 and similarly in 1986 for the private-rental mode (Table 4.2). Where estimates for numbers of discards are available, variance estimates are high. The occurrence of zero discards in some years coupled with high variances for other years are probably indicative of sample size issues in earlier years of the MRFSS for effort and catch estimates. More consistent discard estimates from 1991 onwards may relate to regulatory changes implemented in 1992. However, variance remained high throughout the 1990s. It should be noted that estimates of red snapper discards from shore mode have been excluded.

### 4.4.2 Headboat Logbook Discards

The Southeast Region Headboat Survey logbook form was modified in 2004 to include a category to collect self-reported discards for each reported trip. This category is described on the form as the number of fish by species released alive and number released dead. Port agents instructed each captain on criteria for determining the condition of discarded fish. A fish is considered "released alive" if it is able to swim away on its own. If the fish floats off or is obviously dead or unable to swim, it is considered "released dead". This self-reported data are currently unvalidated within the Headboat Survey. The RWG compared red snapper discard data from the MRFSS At-Sea Observer Headboat program to the Headboat Survey logbook and determined that the logbook discard data were underreported from 2004-2006. However, as reporting compliance improved in recent years (2007-2009), discard reporting on logbooks has also improved. Based on the results of this comparison, it was concluded that discard reporting on headboat logbooks is representative of the headboat fishery from 2007-2009. For years prior to 2007 the RWG considered 6 possible data sources to be used as a proxy for estimated headboat discards (Figure 4.6).

Comparison of discards (percent released) from numerous datasets during 2004-2009 to determine if any can be used as a proxy for HB discards prior to 2007.

- Capt. Steve Amick data (described Section 4.2, SEDAR24-DW07) – Data are limited to just one boat in one state within the region. However, it does extend back through time until the early 1980s. The data do match the scale and pattern from both the region-wide headboat logbook and GA/FL at-Sea observer data for the 2007-2009 time period.
- SC At-sea – Not recommended for use since it is a short time series (2004-2009) with extremely small sample sizes.
- GA/FL At-sea Observer (described Section 4.2, SEDAR-24-DW15) – Because the data are collected by observers, this is the data set in which the RWG has the highest confidence. However, it is a short time series (2005-2009) that does not extend back in time and therefore was not recommended for use.
- SC MRFSS CH – The data set is constrained by small sample size and was not recommended for use.
- FL MRFSS CH – Though it does extend back to 1986, there are sample size concerns and it does not follow the pattern exhibited in the GA/FL at-sea observer data which was the most trusted data set for the 2005-2009 time period. It was not recommended for use.
- SC logbook – Though it does extend back to 1993, it does not follow the pattern exhibited in the GA/FL at-sea observer data which was the most trusted data set for the 2005-2009 time period. Additionally, it is limited to one state that does not contribute a large portion of the red snapper landings. It was not recommended for use.

*Issue 1: Proxy for estimated headboat discards prior to 2007.*

Option 1: Use Amick's discard data to estimate headboat discards prior to 2007.
Option 2: Use a flat ratio based on the 2007-2009 headboat logbook time series.
Option 3: Do not attempt to estimate discards for the HB sector prior to 2004.

**Decision:** Option 1, but also conduct sensitivity runs for Options 2 & 3.

### 4.4.3 Headboat At-Sea Observer Survey Discards

An observer survey of the recreational headboat fishery was launched in NC and SC in 2004 and in GA and FL in 2005 to collect more detailed information on recreational headboat catch, particularly for discarded fish. Headboat vessels are randomly selected throughout the year in each state, and the east coast of Florida is further stratified into northern and southern sample regions. Biologists board selected vessels with permission from the captain and observe anglers as they fish on the recreational trip. Data collected include number and species of fish landed and discarded, size of landed and discarded fish, and the release condition of discarded fish (FL only). Data are also collected on the length of the trip, area fished (inland, state, and federal waters) and, in Florida, the minimum and maximum depth fished. In the Florida Keys (sub-region 3) some vessels that run trips that span more than 24 hours are also sampled to collect information on trips that fish farther offshore and for longer durations, primarily in the vicinity of the Dry Tortugas. This data set provides valuable quantitative information on the ratio of harvested to discarded fish, depths fished, and release condition of fish discarded in the recreational headboat fishery and provides the only available time series on the size distribution of discards (Table 4.12). Survey methods, sample sizes and size distributions of discarded fish are described in detail in SEDAR24-DW15.

#### 4.4.3.1 Discard Mortality

The SEDAR 24 discard mortality working sub-group recommended the use of a depth specific discard mortality rate. This approach was discussed during a plenary session of the SEDAR 24 data workshop. During this plenary session the workshop participants agreed that applying the depth specific discard mortality function to a distribution of depths fished for each gear/sector would be the best approach. This 'integrated' approach was applied to the recreational headboat, charter boat, and private boat modes of fishing.

The depth equation used for this analysis was provided by the discard mortality working sub-group and is as follows:

$$D = 1 \Big/ \left(1 + e^{(-(-2.3915+0.0592*d))}\right)$$

where $D$ is the discard mortality rate and $d$ is the depth in meters.

The depth distributions for each sector of the recreational fishery were developed from data provided by the life history working group. This is composed of fish samples collected through dockside sampling, from the SC tagging program, and by FL headboat observers. For each sample there was an associated length measurement. For the charter boat and headboat sectors there were enough samples to limit the depth analysis to fish equal to or less than 20 inches, the current minimum size limit. Unfortunately the sample sizes for the private boat sector were too small to limit the analysis to just undersized fish and therefore all the samples were used for the depth analysis of the private boat sector. However, the number of fish over 20 inches in the private boat sector represented only about 10% of the fish. A breakdown of the sample sizes by sector and by state is shown in Table 4.13.

One concern with these samples is that the geographic range is limited to primarily GA and FL. Fortunately, the bulk of the red snapper fishery also occurs in these areas. Another concern was that the private recreational sample size was very low (only 55 fish), but still adequate for characterizing the depth of capture of red snapper.

The frequency of depth samples by sector were binned into 25 feet increments and then standardized to sum to unity (Figure 4.7). The pattern from this figure suggests headboats are fishing the shallowest depths, followed by private boats, with charter boats fishing some of the deepest waters. In discussions with fishermen in attendance, this pattern was not unexpected as it largely reflects the speed of boats and their ability to get to deeper waters in a given day of fishing. It was noted that the deeper charter boat fishing is likely a result of some boats heading to offshore waters to troll for pelagic species then switching to bottom fishing during some part of the trip.

The RWG had made a decision to combine the headboat and charter boat sectors into one sector (based on overall data availability), but separate the private boat sector. Because the sampling of fish with depth measurements was not done in proportion to the fishery landings, the depth distributions for charter boat and headboat sectors needed to be weighted before combining into one discard mortality estimate. The charter boat and headboat depth profiles were weighted by the proportion of landings (in numbers) for each sector for years 1986-2006 (the data available at the time these calculations were made). The average ratio of charter:headboat landings in numbers was 0.58 for the years 1986-2006.

Using this ratio for weighting the depth profiles from Figure 4.7, the discard mortality equation above was then applied. Not only were the depth profiles weighted for the combined charter and headboat sectors, but the modes of the distributions were also; but in this case the modes were identical. The results are shown in Table 4.14. It should be noted that the big difference between the mode and integrated estimates for the combined charter/headboat sector is due to the asymmetrical depth distributions for those sectors, which also suggests the use of the integrated method is more appropriate.

## 4.5 Biological Sampling

### MRFSS Charter and Private

The MRFSS angler intercept survey includes the collection of fish lengths from the harvested (landed, whole condition) catch. Up to 15 of each species landed per angler interviewed are measured to the nearest mm along a center line (defined as tip of snout to center of tail along a straight line, not curved over body). Center line lengths (also called mid-line lengths) were converted to maximum total length using the length/length regression provided by the SEDAR24 Life History Workgroup. Weights are typically collected for the same fish measured; however weights are given priority when time is constrained. Ageing structures and other biological samples are rarely collected during MRFSS assignments because of concerns over the introduction of bias to survey data collection.

### Headboat Survey Biological Sampling

Lengths were collected from 1972-2009 by headboat dockside samplers. From 1972-1975, only North Carolina and South Carolina were sampled whereas Georgia and northeast Florida were sampled beginning in 1976. The Southeast Region Headboat Survey conducted dockside sampling for the entire range of Atlantic waters along the southeast portion of the US from the NC-VA border through the Florida Keys beginning in 1978. Weights are typically collected for the same fish measured during dockside sampling. Also, biological samples (scales, otoliths, spines, stomachs and gonads) are collected routinely and processed for aging, food analysis and maturity studies.

### Georgia Department of Natural Resources

Per a request from the NMFS Southeast Regional Office in Spring 2009, GADNR initiated red snapper biological data collection in Georgia from May through November. This effort was independent of dockside interviews with recreational anglers through the MRFSS and sampling the commercial industry through the Trip Interview Program (TIP). In Georgia, per MRFSS estimates, private boat mode fishing effort in federal waters accounted for ~7% of annual angler trips from 2004-2008. Due to expected low incidence rate of trips that were both offshore and in which red snapper were harvested, interviews outside regularly scheduled MRFSS dockside assignments were not conducted. Biological sampling for length is conducted through the TIP program with a goal of sampling a minimum of 10% of the commercial finfish trips landed in Georgia. However, otoliths are not available for those collections. Thus the majority of biological data collected in 2009 (608 fish, 90%) came from three for-hire vessels operating from Tybee Island, Georgia (near Savannah). The captains consistently caught red snapper and were very supportive of the cooperative research effort. The remaining 10% of the sample consisted of carcasses donated by recreational anglers and for-hire captains through the existing GADNR carcass freezer program, though this program did not specifically target red snapper.

The Tybee Island for-hire data collection included several components. During May, data represent a census of all snapper-grouper trips prosecuted by the three vessels (14 sampling days, 284 fish). This initial effort was in preparation for the June SAFMC meeting. Data collected from June through November represent random sampling of the snapper-grouper trips prosecuted by the same three for-hire vessels (22 sampling days, 304 fish). Data from these 588 fish were collected dockside by GADNR personnel. Data elements included length, weight, gender, average trip depth and age (determined from otoliths). Throughout this period, the captains also provided measurements and otoliths from 20 larger fish (30 inches or greater) on days in which GADNR personnel were not available to collect data.

For samples collected from the for-hire vessels in May, FL FWC personnel collaborated with GADNR to process and age one otolith per fish so that comparison age readings between agencies could be produced. This effort was repeated for the Sept-Nov sample. There was an overall 92% agreement, with no difference greater than one year.

### Florida FWC Biological Sampling

Beginning in July, 2009, Florida's Fish and Wildlife Research Institute (FWRI) personnel on the east coast of Florida began to actively sample recreational and commercial catches to collect enhanced biological samples specifically from red snapper. This sampling continued through the month of September, 2009.

During the period, FWRI/FWC staff made routine visits to known red snapper landing sites for for-hire vessels and headboats. These visits were not conducted as part of MRFSS dockside intercept assignments, but were conducted independently and directed towards intercepting red snapper trips. Similar attempts were made to sample red snapper at private boat landing sites, but targeting this fishing mode was not conducive to intercepting red snapper in adequate numbers. For-hire vessels were sampled as they returned from daily fishing trips, and FWC staff sampled all available sizes of red snapper from returned vessels. A total of 328 red snapper otoliths were collected from commercial landing sites, 789 were collected from for-hire landing sites, and 20 were collected from private boat landing sites.

As part of FWC biological sampling efforts a sizeable number (N= 1,479) of red snapper otoliths were available for years 2000-2007 for the East Florida for-hire fishery and included in this analysis. The majority of these fish were collected independently of the MRFSS. Although managed species were targeted, sampling assignments were issued proportionally to fishing effort at MRFSS intercept sites to geographically distribute sampling effort among fishing modes.

### 4.5.1 Sampling Intensity Length/Age/Weight

**At-Sea Observer Program** - Lengths of red snapper discards were collected during headboat at-sea observer trips. Table 4.12, provides the numbers of sampled trips in each state and numbers of red snapper discard lengths by state and year. Midline lengths were converted to maximum total length using the length/length regression equation provided by the SEDAR24 Life History Workgroup. Discard lengths were summed for each 1cm total length category and entered into the Excel Worksheet for SEDAR24 Data Workshop data inputs.

**Dockside Surveys** - Annual numbers of red snapper measured for lengths and the number of trips from which red snapper were measured in MRFSS charter fleet intercepts are summarized in Table 4.15 Annual numbers of red snapper measured for length in the MRFSS private-rental mode and the number of trips from which red snapper were measured are summarized in Table 4.16. Annual numbers of red snapper measured for length in the headboat fleet and the number of trips from which red snapper were measured are summarized in Table 4.17. The number of red snapper aged from the headboat and charter fleets by year and state are summarized in Table 4.18. The number of trips from which red snapper were aged from the headboat and charter fleets by year and state is summarized in Table 4.19. The number of red snapper and the number of trips from which red snapper were aged from the private fleet by year and state is summarized in Table 4.20. Table 4.21 provides details on the numbers of MRFSS intercept surveys conducted by mode and year in each state and the percentage of intercepts that encountered red snapper.

### 4.5.2. Length – Age distributions

#### MRFSS Length Frequency Analysis Private and Charter Fleets Protocol

The angler intercept survey is stratified by wave (2-month period), state, and fishing mode (shore, charter boat, party boat, private or rental boat) so simple aggregations of fish lengths across strata cannot be used to characterize a regional, annual length distribution of landed fish. A weighting scheme is needed to representatively include the distributions of each stratum value. The MRFSS angler intercept length frequency analysis produces unbiased estimates of length-class frequencies for more than one strata by summing respectively weighted relative length-class frequencies across strata. The steps utilized are:

1) output a distribution of measured fish among state/mode/area/wave strata,

2) output a distribution of estimated catch among state/mode/area/wave strata,

3) calculate and output relative length-class frequencies for each state/mode/area/wave stratum,

4) calculate appropriate relative weighting factors to be applied to the length-class frequencies for each state/mode/area/wave stratum prior to pooling among strata,

5) sum across strata as defined, e.g., annual, sub-region length frequencies.

### Headboat Fleet Length Distributions Protocol

Headboat landings (1981-2009) were pooled across five time intervals (Jan-May, Jun,July,Aug,Sep-Dec) because landings were not estimated by month until 1996. The headboat landings were only estimated annually prior to 1981 so, no intra-annual weightings were developed for 1972-1980. Spatial weighting was developed by region for the headboat survey by pooling landings by region: NC, SC, NF (GA and North FL), and SF (South FL). For each measured fish a landings value was assigned based on month of capture and region. The landings associated with each length measurement were summed by year in 1-cm length bins. These landings were typically then converted to annual proportion in each size bin.

### Headboat and Charter Fleet Combined Length Frequency

The headboat and charter boat lengths were weighted temporally and spatially by landings as described above. The scales were slightly different for the surveys due primarily to availability of landings estimates and sampling intensity. The length compositions from each of the fleets were combined at the level of summed landings by year and length bin. This weights the length composition not only temporally and spatially but also provides weighting relative to each of the charter and headboat fleets. These combined values were then converted to an annual proportion at length in 1-cm bins (Figure 4.8, see data summary workbook RS_DW_Summary.xlsx for values).

### Private Fleet Length Frequency

The private fleet length frequency is plotted in Figure 4.9. The table of length compositions is large and provided in the data summary workbook from the SEDAR 24 Data Workshop (RS_DW_Summary.xlsx).

### Headboat and Charter Fleet Combined Age Frequency

The calendar age for each red snapper was matched to the corresponding annual proportion at age in the combined age composition for headboat and charter fleets combined. These ages matched the length of the aged fish and year captured. The annual proportion at age (age frequency) was developed as the sum of the length bin proportion assigned to each fish by year and age normalized to sum to one annually (Figure 4.10, see SEDAR 24 data summary workbook for data). Ages 1-20 were plotted although ages were observed in very small numbers to age 54. This weighting adjusts for any bias in sampling otoliths from a distribution of different sized fish.

### Private Fleet Age Frequency

The calendar age for each red snapper was matched to the corresponding annual proportion at length in the length composition for the private fleet that matched the length of the aged fish. The annual proportion at age (age frequency) was developed as the sum of the length bin proportion assigned to each fish by year and age normalized to sum to one annually (Figure 4.10, see SEDAR 24 data summary workbook for data). Ages 1-20 were plotted although ages were observed in very small numbers to age 54. This weighting adjusts for any bias in sampling otoliths from a distribution of different sized fish.

### 4.5.3 Adequacy for Characterizing Catch

#### Headboat and Charter Fleet Length Composition

The RWG agreed that the headboat and charter fleet length composition from years with incomplete spatial coverage should not be used to characterize the red snapper population. The length composition prior to 1978 is strictly from the headboat fleet and has limited spatial coverage. The RWG recommends starting the length compositions for assessment model HB input in 1978. From 1978-1980 the length composition is only from the headboat fleet since CH data were not collected until the MRFSS started in 1981. The recreational data working group supports the assumption the headboat length composition from 1978-80 should characterize the charter fleet.

The 12-inch size limit implemented in 1983 had little influence on the size of fish landed from headboat vessels (Figure 4.8). Influence of the 20-inch size limit implemented in 1992 is apparent in the length compositions (Figure 4.8).

#### Private Fleet Length Composition

The private fleet length compositions are inadequate to capture the size distribution of red snapper with the possible exception of 2008 and 2009 when sample sizes are higher. It may be possible to increase the sample size by including lengths of aged fish that were not included as MRFSS length samples. This would require additional effort and a preliminary look at the potential increase in sample size would be useful to decide if this exercise would benefit the assessment.

#### Headboat and Charter Fleet Age Composition

The headboat and charter fleet age compositions have sufficient samples to represent the catch during the 1970s and 1980s. However, the sampling declines in the 1990's and may not represent the headboat and charter catch. The sample sizes increase in 2001 and continue through 2009. The age compositions from 2001-2009 are adequate to characterize the red snapper catch.

#### Private Fleet Age Composition

The private fleet age compositions are inadequate to capture the age distribution of red snapper with the possible exception of 2009 when sample sizes are higher. State port agents were targeting red snapper for high frequency sampling in 2009 but the samples were selected randomly.

### 4.5.4 Alternatives for characterizing discards

The RWG had no input on this issue.

## 4.6 Recreational Catch-at-Age/Length; directed and discard

The RWG had no input on this issue.

## 4.7 Recreational Effort

### MRFSS Recreational & Charter Effort

Effort estimation for the recreational fishery surveys are produced via telephone surveys of both anglers (private/rental boats and shore fishers) and for-hire boat operators (charter boat anglers, and in early years, party or charter anglers). The methods have changed during the full time series (see section 4.3 for descriptions of survey method changes and adjustments to survey estimates for uniform time-series of catch estimates). The adjusted charter boat angler effort estimates and the private/rental boat angler estimates are tabulated in Table 4.22 and 4.23. An angler-trip is a single day of fishing in the specified mode, not to exceed 24 hours. Because this data review is for red snapper in the South Atlantic sub-region and shore landings have specifically been excluded (non-reliable identification; red snapper are not considered to be accessible to shore anglers) the shore angling effort has not been included in any tables of angling effort.

### Headboat Effort

Catch and effort data are reported on logbooks provided to all headboats in the SRHS. These forms are completed by the captain or designated crew member after each trip and represent the total number and weight of all the species kept, along with the total number of fish discarded for each species. Data on effort are provided as number of anglers on a given trip. Numbers of anglers are standardized, depending on the type of trip (length in hours), by converting number of anglers to “angler days” (e.g., 40 anglers on a half-day trip would yield 40 * 0.5 = 20 angler days). Angler days are summed by month for individual vessels. Each month, port agents collect these logbook trip reports and check for accuracy and completeness. Although reporting via the logbooks is mandatory, compliance is not 100% and is variable by location. To account for non-reporting, a correction factor is developed based on sampler observations, angler numbers from office books and all available information. This information is used to provide estimates of total catch by month and area, along with estimates of effort.

Estimated headboat angler days have decreased in the South Atlantic in recent years (Table 4.24). The most obvious factor which impacted the headboat fishery in both the Atlantic and Gulf of Mexico was the high price of fuel. This coupled with the economic down turn in 2008 and 2009 has resulted in a marked decline in angler days in the South Atlantic headboat fishery. Reports from industry staff, captains\owners, and port agents indicated throughout the 2008 and 2009 season, fuel prices, the economy and fishing regulations are the factors that most affected the amount of trips, number of passengers, and overall fishing effort.

## 4.8 Comments on adequacy of data for assessment analyses

Regarding the adequacy of the available recreational data for assessment analyses, the RWG discussed the following:

- The RWG discussed the possibility of smoothing MRFSS estimates to overcome high amounts of annual variability in the estimates. It was decided by the group to leave this decision to smooth or not to smooth up to the assessment group.
- Landings, as adjusted, appear to be adequate for the time period covered.
- Size data appear to adequately represent the landed catch for the charter and headboat sector, however, the private sector is lacking in both length and age data.

## 4.9 Itemized list of tasks for completion following workshop

See Section 1.5

## 4.10 Literature Cited

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Sminkey, T. R. 2010. SEDAR24-DW-13. South Atlantic Red Snapper Marine Recreational Fishery Landings: FHS-conversion of Historic MRFSS Charter Boat Catches. Charleston, SC. May 2010.

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## 4.11 Tables

**Table 4.1a**. South Atlantic red snapper landings (numbers of fish) by fishing mode (charter boats and private/rental boats) (MRFSS, NMFS, 1981-2009).

| Number (x1000) | | | | |
|---|---|---|---|---|
| | Landings | | CV(=Percent Standard Error) | |
| Year | MRFSS-CH | MRFSS-PR | MRFSS-CH | MRFSS-PR |
| 1981 | 63.9 | 123.6 | 42.2 | 31.3 |
| 1982 | 5.8 | 54.8 | 47.1 | 33.4 |
| 1983 | 137.7 | 37.3 | 22.4 | 47.0 |
| 1984 | 209.4 | 223.8 | 17.4 | 29.7 |
| 1985 | 302.7 | 260.6 | 20.8 | 32.7 |
| 1986 | 82.4 | 69.2 | 43.7 | 38.2 |
| 1987 | 15.3 | 50.9 | 39.2 | 23.3 |
| 1988 | 26.1 | 95.7 | 42.8 | 33.8 |
| 1989 | 21.0 | 127.7 | 32.4 | 22.9 |
| 1990 | 5.7 | 10.5 | 36.5 | 41.7 |
| 1991 | 16.8 | 34.1 | 25.4 | 44.0 |
| 1992 | 40.3 | 39.0 | 19.6 | 32.7 |
| 1993 | 7.6 | 10.8 | 31.8 | 29.0 |
| 1994 | 14.4 | 13.9 | 34.1 | 44.1 |
| 1995 | 13.6 | 2.4 | 32.0 | 59.0 |
| 1996 | 3.1 | 11.6 | 40.5 | 50.0 |
| 1997 | 57.2 | 3.5 | 61.9 | 60.8 |
| 1998 | 13.4 | 7.6 | 32.8 | 37.5 |
| 1999 | 42.5 | 22.4 | 40.7 | 25.8 |
| 2000 | 11.1 | 60.3 | 22.6 | 24.4 |
| 2001 | 9.9 | 39.5 | 21.9 | 20.5 |
| 2002 | 17.2 | 34.3 | 18.7 | 22.6 |
| 2003 | 18.2 | 16.0 | 27.9 | 24.2 |
| 2004 | 14.0 | 25.5 | 14.1 | 20.4 |
| 2005 | 14.2 | 21.1 | 16.1 | 28.5 |
| 2006 | 11.3 | 14.6 | 16.5 | 31.4 |
| 2007 | 10.4 | 30.8 | 15.7 | 26.2 |
| 2008 | 22.8 | 86.9 | 19.2 | 18.7 |
| 2009 | 28.7 | 91.9 | 22.1 | 18.4 |

**Table 4.1b**. South Atlantic red snapper landings (pounds of fish) by fishing mode (charter boats and private/rental boats) (MRFSS, NMFS, 1981-2009).

| Weight lbs. (x1000) | | | | |
|---|---|---|---|---|
| | Landings | | CV(=Percent Standard Error) | |
| Year | MRFSS-CH | MRFSS-PR | MRFSS-CH | MRFSS-PR |
| 1981 | 70.4 | 349.1 | 41.6 | 37.4 |
| 1982 | 15.2 | 151.2 | 63.5 | 28.3 |
| 1983 | 151.8 | 88.3 | 20.7 | 54.2 |
| 1984 | 230.8 | 246.3 | 16.8 | 28.4 |
| 1985 | 333.7 | 1015.3 | 22.9 | 37.6 |
| 1986 | 36.3 | 66.9 | 30.6 | 41.2 |
| 1987 | 43.8 | 97.5 | 34.3 | 24.3 |
| 1988 | 69.1 | 74.6 | 40.3 | 34.5 |
| 1989 | 64.8 | 185.8 | 32.9 | 38.6 |
| 1990 | 5.1 | 172.0 | 30.2 | 50.0 |
| 1991 | 73.9 | 89.7 | 28.9 | 48.3 |
| 1992 | 284.4 | 320.2 | 53.6 | 54.6 |
| 1993 | 67.0 | 98.6 | 33.6 | 38.3 |
| 1994 | 126.7 | 80.4 | 30.0 | 80.5 |
| 1995 | 63.0 | 13.2 | 33.7 | 37.9 |
| 1996 | 20.1 | 89.0 | 42.3 | 59.3 |
| 1997 | 126.0 | 22.4 | 56.5 | 42.4 |
| 1998 | 88.4 | 54.1 | 44.4 | 45.3 |
| 1999 | 112.5 | 75.8 | 22.8 | 28.4 |
| 2000 | 53.7 | 434.0 | 22.0 | 27.3 |
| 2001 | 67.3 | 267.1 | 21.8 | 23.8 |
| 2002 | 106.1 | 274.9 | 18.2 | 22.8 |
| 2003 | 120.3 | 147.2 | 19.5 | 27.9 |
| 2004 | 120.0 | 173.1 | 16.3 | 23.4 |
| 2005 | 119.0 | 139.5 | 15.4 | 28.8 |
| 2006 | 102.6 | 138.9 | 17.2 | 40.3 |
| 2007 | 73.6 | 243.8 | 19.2 | 36.6 |
| 2008 | 151.0 | 534.9 | 23.5 | 19.7 |
| 2009 | 221.5 | 645.7 | 30.3 | 19.7 |

**Table 4.2.** South Atlantic red snapper discards by fishing mode (charter boats and private/rental boats) (MRFSS, NMFS, 1981-2009).

| Number (x1000) | | | | |
|---|---|---|---|---|
| | Discards | | CV(=Percent Standard Error) | |
| Year | MRFSS-CH | MRFSS-PR | MRFSS-CH | MRFSS-PR |
| 1981 | 2.3 | 0.0 | 100.0 | |
| 1982 | 0.0 | 0.0 | | |
| 1983 | 42.3 | 0.0 | 37.1 | |
| 1984 | 121.7 | 22.8 | 35.4 | 51.6 |
| 1985 | 27.8 | 63.5 | 54.8 | 58.8 |
| 1986 | 0.0 | 0.0 | | |
| 1987 | 0.2 | 106.6 | 100.0 | 57.9 |
| 1988 | 0.0 | 48.4 | | 47.3 |
| 1989 | 0.0 | 20.0 | | 41.9 |
| 1990 | 0.0 | 0.0 | | |
| 1991 | 0.1 | 35.9 | 99.8 | 51.7 |
| 1992 | 13.3 | 19.5 | 47.8 | 38.8 |
| 1993 | 27.5 | 49.0 | 49.2 | 32.5 |
| 1994 | 2.0 | 62.6 | 51.2 | 29.5 |
| 1995 | 19.5 | 37.9 | 40.2 | 24.4 |
| 1996 | 2.8 | 17.6 | 41.4 | 42.6 |
| 1997 | 14.2 | 8.7 | 44.4 | 35.2 |
| 1998 | 5.0 | 23.0 | 45.1 | 38.1 |
| 1999 | 42.2 | 132.7 | 23.0 | 19.5 |
| 2000 | 25.1 | 223.3 | 18.5 | 16.9 |
| 2001 | 24.1 | 179.3 | 14.8 | 15.9 |
| 2002 | 20.2 | 105.9 | 13.3 | 22.4 |
| 2003 | 18.5 | 139.4 | 22.0 | 18.3 |
| 2004 | 30.2 | 164.0 | 15.4 | 16.4 |
| 2005 | 43.3 | 79.7 | 15.6 | 18.9 |
| 2006 | 19.0 | 115.6 | 16.4 | 21.4 |
| 2007 | 112.3 | 339.1 | 27.3 | 14.5 |
| 2008 | 48.4 | 352.2 | 17.1 | 11.8 |
| 2009 | 26.1 | 183.9 | 27.1 | 13.7 |

**4.3.** Estimated number of red snapper - headboat landings 1972-1980.

| Year | NC | SC | NEFL | SEFL | Total |
|---|---|---|---|---|---|
| 1972 | 1222 | 965 | | | 2187 |
| 1973 | 2367 | 1615 | | | 3982 |
| 1974 | 1885 | 1511 | | | 3396 |
| 1975 | 1351 | 3872 | | | 5223 |
| 1976 | 2212 | 3546 | 59473 | | 65231 |
| 1977 | 1049 | 1316 | 42110 | | 44475 |
| 1978 | 959 | 1248 | 43228 | 407 | 45842 |
| 1979 | 441 | 668 | 30924 | 333 | 32366 |
| 1980 | 424 | 2893 | 17840 | 441 | 21598 |

Years\areas not covered by the Headboat Survey

Estimated landings not available for SEDAR 15

**Table 4.4** Comparison of 3 and 5 year ratios for estimated red snapper headboat landings 1972-1980.

| Year | Total # 3 yr ratio | Total # 5 yr ratio | Total lbs 3 yr ratio | Total lbs 5 yr ratio |
|---|---|---|---|---|
| 1972 | 37426 | 38204 | 165049 | 178729 |
| 1973 | 68144 | 69560 | 286232 | 311141 |
| 1974 | 58115 | 59323 | 229560 | 250803 |
| 1975 | 89381 | 91238 | 336252 | 368923 |
| 1976 | 66105 | 66691 | 234941 | 233966 |
| 1977 | 45071 | 45470 | 195198 | 194696 |
| 1978 | 45842 | 45842 | 171454 | 171454 |
| 1979 | 32366 | 32366 | 183519 | 183519 |
| 1980 | 21598 | 21598 | 74501 | 74501 |

**Table 4.5.** Estimated landings of red snapper in the South Atlantic headboat fishery 1972-2009.

| Area | North Carolina | | South Carolina | | Georgia \NE Florida | | SE Florida | |
|---|---|---|---|---|---|---|---|---|
| Year | Number | Weight (lbs) | Number | Weight (lbs) | Number | Weight (lbs) | Number | Weight (lbs) |
| 1972 | 1222 | 22042 | 965 | 18874 | 34789 | 120028 | 450 | 4105 |
| 1973 | 2367 | 32456 | 1615 | 27758 | 63342 | 218543 | 820 | 7474 |
| 1974 | 1885 | 22727 | 1511 | 14077 | 54020 | 186382 | 699 | 6375 |
| 1975 | 1351 | 12842 | 3872 | 26954 | 83082 | 286652 | 1075 | 9804 |
| 1976 | 2212 | 14961 | 3546 | 39959 | 59473 | 172053 | 874 | 7969 |
| 1977 | 1049 | 7233 | 1316 | 11083 | 42110 | 171449 | 596 | 5433 |
| 1978 | 959 | 12421 | 1248 | 8962 | 43228 | 146380 | 407 | 3691 |
| 1979 | 441 | 5101 | 668 | 9127 | 30924 | 165827 | 333 | 3463 |
| 1980 | 424 | 2950 | 2893 | 11649 | 17840 | 56425 | 441 | 3477 |
| 1981 | 1194 | 7742 | 1371 | 8762 | 32415 | 98464 | 1051 | 3062 |
| 1982 | 747 | 10487 | 1612 | 14535 | 16412 | 69778 | 782 | 3224 |
| 1983 | 416 | 5316 | 1844 | 10179 | 27124 | 55365 | 1314 | 3143 |
| 1984 | 740 | 4582 | 1841 | 6875 | 27934 | 68115 | 631 | 1846 |
| 1985 | 8426 | 31330 | 2183 | 11768 | 38072 | 83964 | 1655 | 5022 |
| 1986 | 997 | 7129 | 881 | 4515 | 14286 | 40495 | 461 | 2241 |
| 1987 | 5346 | 21518 | 1934 | 6310 | 17155 | 52327 | 561 | 1685 |
| 1988 | 9555 | 36829 | 5235 | 15250 | 13589 | 50201 | 8148 | 27791 |
| 1989 | 1134 | 6691 | 6207 | 26459 | 15114 | 35984 | 998 | 1662 |
| 1990 | 525 | 2749 | 3650 | 13341 | 15422 | 46076 | 1322 | 3520 |
| 1991 | 725 | 15991 | 3290 | 21781 | 9580 | 33128 | 262 | 1131 |
| 1992 | 2306 | 12049 | 1275 | 5924 | 1310 | 8412 | 410 | 2531 |
| 1993 | 1639 | 9043 | 3623 | 19866 | 1541 | 10598 | 544 | 3211 |
| 1994 | 567 | 3632 | 2454 | 6349 | 3576 | 21909 | 1628 | 11127 |
| 1995 | 3791 | 23728 | 866 | 6340 | 3634 | 23732 | 535 | 3674 |
| 1996 | 335 | 3130 | 2374 | 23837 | 2683 | 18300 | 151 | 968 |
| 1997 | 1779 | 20969 | 557 | 6746 | 2794 | 20316 | 640 | 3174 |
| 1998 | 445 | 1082 | 696 | 6235 | 3426 | 18591 | 174 | 939 |
| 1999 | 973 | 6957 | 1749 | 11257 | 3559 | 22153 | 555 | 3192 |
| 2000 | 777 | 5946 | 984 | 6562 | 6463 | 35818 | 213 | 1076 |
| 2001 | 1816 | 9605 | 3878 | 20513 | 6023 | 36403 | 311 | 1864 |
| 2002 | 2637 | 14194 | 4345 | 21727 | 5722 | 33993 | 227 | 883 |
| 2003 | 399 | 3679 | 1346 | 12133 | 3910 | 25242 | 51 | 299 |
| 2004 | 1274 | 12300 | 1672 | 16111 | 7786 | 51081 | 110 | 857 |
| 2005 | 106 | 1114 | 1004 | 10399 | 6681 | 40742 | 1116 | 6441 |
| 2006 | 33 | 384 | 303 | 3540 | 5393 | 36050 | 216 | 1458 |
| 2007 | 52 | 389 | 701 | 5016 | 5311 | 27861 | 825 | 4193 |
| 2008 | 162 | 888 | 1551 | 8076 | 17028 | 105436 | 202 | 908 |
| 2009 | 263 | 2368 | 373 | 5105 | 20107 | 127587 | 764 | 6028 |

**Table 4.6.** Statistics for ratios of recreational to commercial landings data based on the number of fish landed**.**

| **Ratio** | **Mean** | **StDev** | **Min** | **Max** |
|---|---|---|---|---|
| For-Hire:Commercial | 2.27 | 1.90 | 0.41 | 6.75 |
| Private:Commercial | 2.19 | 1.53 | 0.21 | 4.98 |

**Table 4.7** Estimated historical recreational landings (numbers) of red snapper for the charter boat, total for-hire (charter and headboat combined), and private boat sectors in the U.S. South Atlantic using the ratio method

| Year | Charter Boat | Total For-Hire | Private Boat |
|---|---|---|---|
| **1950** | | 164,137 | 0 |
| **1951** | | 237,178 | 6,190 |
| **1952** | | 178,388 | 9,311 |
| **1953** | | 184,161 | 14,418 |
| **1954** | | 274,294 | 28,633 |
| **1955** | | 228,105 | 29,765 |
| **1956** | | 221,919 | 34,749 |
| **1957** | | 398,153 | 72,735 |
| **1958** | | 282,863 | 59,056 |
| **1959** | | 303,667 | 71,324 |
| **1960** | | 310,265 | 80,971 |
| **1961** | | 366,490 | 105,977 |
| **1962** | | 303,617 | 96,356 |
| **1963** | | 231,355 | 79,946 |
| **1964** | | 256,377 | 95,820 |
| **1965** | | 300,963 | 120,970 |
| **1966** | | 339,115 | 145,865 |
| **1967** | | 442,365 | 202,748 |
| **1968** | | 490,230 | 238,508 |
| **1969** | | 321,170 | 165,311 |
| **1970** | | 293,906 | 159,564 |
| **1971** | | 249,779 | 146,145 |
| **1972** | 178,032 | | 135,153 |
| **1973** | 109,621 | | 119,008 |
| **1974** | 232,309 | | 206,683 |
| **1975** | 252,594 | | 257,796 |
| **1976** | 218,316 | | 226,409 |
| **1977** | 253,420 | | 250,202 |
| **1978** | 225,839 | | 239,191 |
| **1979** | 155,860 | | 173,656 |
| **1980** | 153,036 | | 168,484 |

**Table 4.8.** Estimated range of historical recreational landings (numbers) of red snapper for the charter boat, total for-hire (charter and headboat combined), and private boat sectors in the U.S. South Atlantic using the ratio method.

| Year | Minimum Charter Boat | Maximum Charter Boat | Minimum Total For-Hire | Maximum Total For-Hire | Minimum Private Boat | Maximum Private Boat |
|---|---|---|---|---|---|---|
| **1950** | | | 29,586 | 488,562 | 0 | 0 |
| **1951** | | | 42,751 | 705,973 | 602 | 14,094 |
| **1952** | | | 32,154 | 530,980 | 906 | 21,200 |
| **1953** | | | 33,195 | 548,166 | 1,402 | 32,830 |
| **1954** | | | 49,442 | 816,452 | 2,785 | 65,197 |
| **1955** | | | 41,116 | 678,967 | 2,895 | 67,772 |
| **1956** | | | 40,001 | 660,554 | 3,379 | 79,121 |
| **1957** | | | 71,767 | 1,185,123 | 7,074 | 165,614 |
| **1958** | | | 50,986 | 841,957 | 5,743 | 134,467 |
| **1959** | | | 54,736 | 903,880 | 6,937 | 162,401 |
| **1960** | | | 55,925 | 923,520 | 7,875 | 184,366 |
| **1961** | | | 66,060 | 1,090,875 | 10,307 | 241,303 |
| **1962** | | | 54,727 | 903,731 | 9,371 | 219,397 |
| **1963** | | | 41,702 | 688,640 | 7,775 | 182,031 |
| **1964** | | | 46,212 | 763,119 | 9,319 | 218,177 |
| **1965** | | | 54,249 | 895,833 | 11,765 | 275,440 |
| **1966** | | | 61,126 | 1,009,394 | 14,186 | 332,126 |
| **1967** | | | 79,736 | 1,316,723 | 19,718 | 461,646 |
| **1968** | | | 88,364 | 1,459,196 | 23,196 | 543,068 |
| **1969** | | | 57,891 | 955,980 | 16,077 | 376,404 |
| **1970** | | | 52,977 | 874,828 | 15,518 | 363,318 |
| **1971** | | | 45,023 | 743,481 | 14,213 | 332,763 |
| **1972** | 1,410 | 603,896 | | | 13,144 | 307,736 |
| **1973** | 0 | 460,981 | | | 11,574 | 270,974 |
| **1974** | 0 | 806,347 | | | 20,101 | 470,604 |
| **1975** | 0 | 928,524 | | | 25,072 | 586,986 |
| **1976** | 0 | 780,490 | | | 22,019 | 515,519 |
| **1977** | 8,732 | 843,404 | | | 24,333 | 569,694 |
| **1978** | 3,129 | 762,832 | | | 23,262 | 544,623 |
| **1979** | 1,562 | 527,898 | | | 16,889 | 395,405 |
| **1980** | 9,880 | 498,208 | | | 16,386 | 383,627 |

**Table 4.9.** Estimated historical recreational landings (numbers) of red snapper from the 1960, 1965, and 1970 US Fish and Wildlife Service Salt-water Angling Surveys (SWAS) for the U.S. South Atlantic.

| Year | Total Recreational (1000s) |
|---|---|
| 1946 | 0.00 |
| 1947 | 20.22 |
| 1948 | 40.44 |
| 1949 | 60.67 |
| 1950 | 80.89 |
| 1951 | 101.11 |
| 1952 | 121.33 |
| 1953 | 141.55 |
| 1954 | 161.77 |
| 1955 | 182.00 |
| 1956 | 202.22 |
| 1957 | 222.44 |
| 1958 | 242.66 |
| 1959 | 262.88 |
| 1960 | 283.10 |
| 1961 | 262.78 |
| 1962 | 242.46 |
| 1963 | 222.14 |
| 1964 | 201.82 |
| 1965 | 181.50 |
| 1966 | 280.50 |
| 1967 | 379.50 |
| 1968 | 478.50 |
| 1969 | 577.50 |
| 1970 | 676.50 |
| 1971 | 635.20 |
| 1972 | 593.91 |
| 1973 | 552.61 |
| 1974 | 511.31 |
| 1975 | 470.02 |
| 1976 | 428.72 |
| 1977 | 387.42 |
| 1978 | 346.12 |
| 1979 | 304.83 |
| 1980 | 263.53 |

**Table 4.10.** Annual red snapper catch and harvest per unit of effort from SCDNR Charter boat logbook program, 1993 – 2009.

| Year | Vessel Trips | Average Number Anglers per Vessel Trip | Total Catch per Angler Trip | Total Harvest per Angler Trip | % Released | % Vessel Trips With Catch |
|---|---|---|---|---|---|---|
| 1993 | 565 | 4.46 | 0.21 | 0.11 | 45.97 | 17.17 |
| 1994 | 655 | 4.46 | 0.13 | 0.06 | 54.26 | 15.42 |
| 1995 | 531 | 4.43 | 0.08 | 0.04 | 45.26 | 11.86 |
| 1996 | 696 | 4.41 | 0.06 | 0.05 | 11.05 | 8.05 |
| 1997 | 749 | 4.55 | 0.02 | 0.01 | 45.57 | 5.34 |
| 1998 | 903 | 4.39 | 0.10 | 0.06 | 44.61 | 11.96 |
| 1999 | 844 | 4.48 | 0.18 | 0.12 | 32.79 | 17.42 |
| 2000 | 997 | 4.33 | 0.28 | 0.08 | 72.25 | 15.75 |
| 2001 | 980 | 4.42 | 0.42 | 0.14 | 67.72 | 19.08 |
| 2002 | 937 | 4.33 | 0.30 | 0.14 | 53.53 | 17.61 |
| 2003 | 898 | 4.36 | 0.14 | 0.06 | 54.02 | 12.81 |
| 2004 | 1044 | 4.10 | 0.09 | 0.05 | 43.13 | 9.67 |
| 2005 | 1130 | 4.09 | 0.08 | 0.04 | 42.54 | 9.73 |
| 2006 | 1142 | 4.11 | 0.05 | 0.02 | 53.51 | 6.04 |
| 2007 | 1172 | 4.10 | 0.09 | 0.04 | 57.31 | 9.47 |
| 2008 | 1150 | 4.03 | 0.18 | 0.05 | 72.43 | 12.78 |
| 2009 | 867 | 4.10 | 0.19 | 0.07 | 62.39 | 13.73 |

**Table 4.11.** SC angler based tagging program, number of fish measured (excludes estimated measurements), mean size (inches), and minimum and maximum size range (inches), 1991 – 2009.

| Year | Number of Fish Measured | Mean Length (inches) | Range (inches) |
|---|---|---|---|
| 1991 | 2 | 12.8 | 11.5-14.0 |
| 1992 | 57 | 16.8 | 12.0-20.0 |
| 1993 | 117 | 16.9 | 10.0-21.0 |
| 1994 | 81 | 17.1 | 11.0-19.5 |
| 1995 | 66 | 17.2 | 11.0-20.0 |
| 1996 | 52 | 17.9 | 9.0-24.0 |
| 1997 | 71 | 17.1 | 11.0-22.0 |
| 1998 | 147 | 16.4 | 9.0-21.0 |
| 1999 | 155 | 16.6 | 10.5-29.8 |
| 2000 | 95 | 16.7 | 10.0-22.0 |
| 2001 | 166 | 17.4 | 12.5-33.0 |
| 2002 | 81 | 18.6 | 13.0-29.5 |
| 2003 | 28 | 17.2 | 12.0-19.5 |
| 2004 | 34 | 18.9 | 14.0-30.0 |
| 2005 | 41 | 18.3 | 14.0-22.0 |
| 2006 | 13 | 17.2 | 13.5-19.5 |
| 2007 | 23 | 17.4 | 14.0-23.0 |
| 2008 | 16 | 18.2 | 15.0-20.5 |
| 2009 | 6 | 18.3 | 17.0-19.5 |

**Table 4.12.** Numbers of headboat at-sea observer trips and red snapper discards measured during headboat at-sea observer trips in the South Atlantic.

| State | Year | Observed Headboat Trips | Number measured | Minimum (mm FL) | Maximum (mm FL) | Mean (mm FL) |
|---|---|---|---|---|---|---|
| Florida | 2005 | 172 | 490 | 93 | 548 | 382.767 |
| | 2006 | 161 | 664 | 182 | 550 | 325.571 |
| | 2007 | 166 | 1,474 | 190 | 544 | 357.021 |
| | 2008 | 128 | 1,615 | 180 | 522 | 360.958 |
| | 2009 | 128 | 402 | 142 | 508 | 379.293 |
| Georgia | 2005 | 1 | 2 | 437 | 485 | 461.000 |
| | 2006 | 3 | 8 | 209 | 482 | 354.875 |
| | 2007 | 2 | 8 | 343 | 429 | 390.500 |
| | 2008 | 2 | 38 | 237 | 581 | 382.579 |
| | 2009 | 6 | 71 | 204 | 461 | 311.732 |
| South Carolina | 2004 | 3 | 2 | 375 | 445 | 410.000 |
| | 2005 | 57 | 0 | - | - | - |
| | 2006 | 44 | 0 | - | - | - |
| | 2007 | 52 | 1 | 455 | 455 | 455.000 |
| | 2008 | 39 | 0 | - | - | - |
| | 2009 | 34 | 0 | - | - | - |
| North Carolina | 2004 | 29 | 0 | - | - | - |
| | 2005 | 97 | 0 | - | - | - |
| | 2006 | 82 | 0 | - | - | - |
| | 2007 | 89 | 13 | 280 | 435 | 350.154 |
| | 2008 | 77 | 23 | 265 | 468 | 388.739 |
| | 2009 | 69 | 3 | 420 | 480 | 454.333 |

**Table 4.13**. Number of recreational samples with depth records by state and sector.

| | State | | | |
|---|---|---|---|---|
| **Recreational Sector** | **FL** | **GA** | **SC** | **Grand Total** |
| **Charter Boat (≤ 20 inches)** | 360 | 26 | 40 | 426 |
| **Headboat (≤ 20 inches)** | 4718 | 41 | | 4759 |
| **Private Boat (all)** | 25 | 9 | 24 | 58 |
| **Grand Total** | 5103 | 76 | 64 | 5243 |

**Table 4.14**. Estimated discard mortality rates for the recreational sectors are indicated. The mode was applied as a single point estimate to the mortality equation, while the integrated method used the depth profiles. The charter and headboat sectors were combined using an average weighting method based on the ratio of the sector's landings in numbers.

| | **Mode** | **Integrated** |
|---|---|---|
| Charter and Headboat (fish ≤ 20") | 30.7% | 41.3% |
| Private Boat (all) | 41.1% | 38.9% |

**Table 4.15.** Number of red snapper measured and number of trips with red snapper in the MRFSS charter fleet by year and state.

| | Number of Fish | | | | | Number of Trips | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | NC | SC | GA | FL | Total | NC | SC | GA | FL | Total |
| 1981 | 0 | 6 | 0 | 13 | 19 | 0 | 1 | 0 | 7 | 8 |
| 1982 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 1983 | 0 | 39 | 0 | 109 | 148 | 0 | 9 | 0 | 46 | 55 |
| 1984 | 7 | 10 | 10 | 302 | 329 | 2 | 9 | 1 | 80 | 92 |
| 1985 | 35 | 0 | 5 | 173 | 213 | 7 | 0 | 2 | 57 | 66 |
| 1986 | 0 | 1 | 0 | 205 | 206 | 0 | 1 | 0 | 73 | 74 |
| 1987 | 24 | 0 | 1 | 0 | 25 | 5 | 0 | 1 | 0 | 6 |
| 1988 | 13 | 0 | 0 | 8 | 21 | 7 | 0 | 0 | 4 | 11 |
| 1989 | 8 | 4 | 4 | 5 | 21 | 6 | 3 | 1 | 2 | 12 |
| 1990 | 14 | 0 | 0 | 0 | 14 | 3 | 0 | 0 | 0 | 3 |
| 1991 | 10 | 0 | 3 | 0 | 13 | 5 | 0 | 2 | 0 | 7 |
| 1992 | 3 | 0 | 1 | 4 | 8 | 3 | 0 | 1 | 2 | 6 |
| 1993 | 4 | 0 | 11 | 0 | 15 | 3 | 0 | 8 | 0 | 11 |
| 1994 | 14 | 0 | 18 | 3 | 35 | 10 | 0 | 10 | 2 | 22 |
| 1995 | 11 | 0 | 9 | 4 | 24 | 5 | 0 | 4 | 1 | 10 |
| 1996 | 4 | 2 | 3 | 0 | 9 | 1 | 2 | 3 | 0 | 6 |
| 1997 | 0 | 16 | 2 | 2 | 20 | 0 | 2 | 2 | 1 | 5 |
| 1998 | 0 | 11 | 11 | 4 | 26 | 0 | 3 | 4 | 2 | 9 |
| 1999 | 8 | 68 | 17 | 14 | 107 | 3 | 10 | 3 | 7 | 23 |
| 2000 | 1 | 20 | 4 | 51 | 76 | 1 | 3 | 2 | 18 | 24 |
| 2001 | 7 | 8 | 3 | 70 | 88 | 6 | 1 | 2 | 24 | 33 |
| 2002 | 12 | 4 | 2 | 181 | 199 | 8 | 2 | 1 | 32 | 43 |
| 2003 | 21 | 1 | 9 | 126 | 157 | 7 | 1 | 4 | 34 | 46 |
| 2004 | 1 | 6 | 37 | 83 | 127 | 1 | 6 | 11 | 23 | 41 |
| 2005 | 2 | 0 | 11 | 50 | 63 | 1 | 0 | 4 | 18 | 23 |
| 2006 | 12 | 3 | 10 | 38 | 63 | 3 | 3 | 4 | 13 | 23 |
| 2007 | 0 | 1 | 18 | 26 | 45 | 0 | 1 | 7 | 9 | 17 |
| 2008 | 10 | 2 | 49 | 34 | 95 | 5 | 1 | 12 | 8 | 26 |
| 2009 | 5 | 0 | 60 | 39 | 104 | 3 | 0 | 12 | 9 | 24 |

**Table 4.16.** Number of red snapper measured and number of trips with red snapper in the MRFSS private fleet by year and state.

| | Number of Fish | | | | | Number of Trips | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | NC | SC | GA | FL | Total | NC | SC | GA | FL | Total |
| 1981 | 0 | 0 | 0 | 25 | 25 | 0 | 0 | 0 | 10 | 10 |
| 1982 | 0 | 0 | 0 | 28 | 28 | 0 | 0 | 0 | 10 | 10 |
| 1983 | 0 | 0 | 2 | 11 | 13 | 0 | 0 | 1 | 2 | 3 |
| 1984 | 0 | 0 | 0 | 41 | 41 | 0 | 0 | 0 | 9 | 9 |
| 1985 | 0 | 0 | 4 | 32 | 36 | 0 | 0 | 3 | 11 | 14 |
| 1986 | 0 | 0 | 1 | 19 | 20 | 0 | 0 | 1 | 8 | 9 |
| 1987 | 12 | 0 | 9 | 17 | 38 | 3 | 0 | 2 | 5 | 10 |
| 1988 | 14 | 0 | 0 | 38 | 52 | 4 | 0 | 0 | 12 | 16 |
| 1989 | 0 | 1 | 0 | 32 | 33 | 0 | 1 | 0 | 11 | 12 |
| 1990 | 2 | 0 | 0 | 2 | 4 | 2 | 0 | 0 | 2 | 4 |
| 1991 | 2 | 0 | 0 | 1 | 3 | 1 | 0 | 0 | 1 | 2 |
| 1992 | 2 | 0 | 1 | 6 | 9 | 1 | 0 | 1 | 3 | 5 |
| 1993 | 0 | 0 | 0 | 8 | 8 | 0 | 0 | 0 | 4 | 4 |
| 1994 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 2 | 2 |
| 1995 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 2 | 2 |
| 1996 | 2 | 0 | 0 | 4 | 6 | 1 | 0 | 0 | 2 | 3 |
| 1997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 0 | 1 | 0 | 6 | 7 | 0 | 1 | 0 | 4 | 5 |
| 1999 | 0 | 0 | 0 | 25 | 25 | 0 | 0 | 0 | 11 | 11 |
| 2000 | 0 | 2 | 0 | 14 | 16 | 0 | 1 | 0 | 12 | 13 |
| 2001 | 0 | 0 | 0 | 32 | 32 | 0 | 0 | 0 | 14 | 14 |
| 2002 | 0 | 0 | 0 | 33 | 33 | 0 | 0 | 0 | 9 | 9 |
| 2003 | 0 | 2 | 0 | 7 | 9 | 0 | 1 | 0 | 5 | 6 |
| 2004 | 1 | 0 | 3 | 25 | 29 | 1 | 0 | 1 | 10 | 12 |
| 2005 | 2 | 0 | 0 | 11 | 13 | 2 | 0 | 0 | 5 | 7 |
| 2006 | 1 | 0 | 4 | 9 | 14 | 1 | 0 | 1 | 6 | 8 |
| 2007 | 0 | 2 | 1 | 15 | 18 | 0 | 1 | 1 | 6 | 8 |
| 2008 | 0 | 0 | 8 | 91 | 99 | 0 | 0 | 3 | 28 | 31 |
| 2009 | 4 | 0 | 1 | 108 | 113 | 3 | 0 | 1 | 21 | 25 |

**Table 4.17.** Number of red snapper measured and number of trips with red snapper in the headboat fleet by year and state.

| | Number of Fish | | | | | Number of Trips | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | NC | SC | NF | SF | Total | NC | SC | NF | SF | Total |
| 1972 | 20 | 30 | | | 50 | 12 | 19 | | | 31 |
| 1973 | 20 | 20 | | | 40 | 12 | 18 | | | 30 |
| 1974 | 27 | 65 | | | 92 | 17 | 32 | | | 49 |
| 1975 | 57 | 91 | | | 148 | 36 | 39 | | | 75 |
| 1976 | 120 | 51 | 303 | | 474 | 42 | 28 | 45 | | 115 |
| 1977 | 54 | 82 | 577 | | 713 | 27 | 43 | 125 | | 195 |
| 1978 | 49 | 45 | 643 | 3 | 740 | 22 | 25 | 159 | 2 | 208 |
| 1979 | 7 | 8 | 226 | 4 | 245 | 5 | 6 | 77 | 3 | 91 |
| 1980 | 10 | 14 | 213 | 22 | 259 | 9 | 10 | 68 | 6 | 93 |
| 1981 | 17 | 3 | 611 | 43 | 674 | 13 | 3 | 172 | 12 | 200 |
| 1982 | 30 | 6 | 415 | 6 | 457 | 16 | 5 | 132 | 1 | 154 |
| 1983 | 53 | 24 | 903 | 26 | 1006 | 32 | 18 | 191 | 12 | 253 |
| 1984 | 48 | 103 | 1063 | 106 | 1320 | 26 | 59 | 208 | 21 | 314 |
| 1985 | 169 | 51 | 894 | 76 | 1190 | 59 | 22 | 190 | 27 | 298 |
| 1986 | 51 | 30 | 334 | 20 | 435 | 35 | 16 | 128 | 11 | 190 |
| 1987 | 50 | 53 | 197 | 6 | 306 | 30 | 28 | 96 | 4 | 158 |
| 1988 | 64 | 43 | 95 | 4 | 206 | 37 | 29 | 48 | 3 | 117 |
| 1989 | 50 | 53 | 250 | 21 | 374 | 26 | 33 | 92 | 9 | 160 |
| 1990 | 31 | 43 | 293 | | 367 | 17 | 19 | 101 | | 137 |
| 1991 | 7 | 29 | 113 | 3 | 152 | 7 | 14 | 41 | 2 | 64 |
| 1992 | 20 | 25 | 28 | | 73 | 16 | 16 | 17 | | 49 |
| 1993 | 22 | 128 | 43 | 10 | 203 | 15 | 52 | 27 | 2 | 96 |
| 1994 | 14 | 58 | 54 | 6 | 132 | 11 | 21 | 27 | 2 | 61 |
| 1995 | 13 | 41 | 91 | 2 | 147 | 9 | 22 | 41 | 2 | 74 |
| 1996 | 7 | 106 | 55 | | 168 | 6 | 38 | 29 | | 73 |
| 1997 | 4 | 14 | 53 | 5 | 76 | 3 | 12 | 31 | 3 | 49 |
| 1998 | 11 | 33 | 112 | 1 | 157 | 7 | 20 | 55 | 1 | 83 |
| 1999 | 7 | 14 | 139 | 1 | 161 | 6 | 11 | 72 | 1 | 90 |
| 2000 | 7 | 9 | 105 | 2 | 123 | 6 | 5 | 57 | 2 | 70 |
| 2001 | 17 | | 230 | 7 | 254 | 15 | | 99 | 4 | 118 |
| 2002 | 8 | 12 | 333 | 8 | 361 | 7 | 8 | 137 | 5 | 157 |
| 2003 | 9 | 21 | 297 | 2 | 329 | 8 | 16 | 120 | 1 | 145 |
| 2004 | 5 | 10 | 267 | 22 | 304 | 5 | 7 | 100 | 1 | 113 |
| 2005 | 3 | 3 | 171 | 16 | 193 | 1 | 2 | 84 | 8 | 95 |
| 2006 | 4 | 9 | 149 | 10 | 172 | 4 | 7 | 83 | 8 | 102 |
| 2007 | 2 | 15 | 149 | 4 | 170 | 2 | 12 | 51 | 4 | 69 |
| 2008 | 10 | 12 | 426 | 7 | 455 | 6 | 4 | 77 | 4 | 91 |
| 2009 | 16 | 12 | 712 | 25 | 765 | 12 | 8 | 157 | 9 | 186 |

**Table 4.18.** Number of red snapper aged from the headboat and charter fleets (combined) by year and state.

| Year | NC | SC | GA | FL | Total |
|---|---|---|---|---|---|
| 1977 | | 12 | | 60 | 72 |
| 1978 | 1 | 2 | 4 | 272 | 279 |
| 1979 | | 1 | | 46 | 47 |
| 1980 | 2 | 5 | | 87 | 94 |
| 1981 | 3 | | | 412 | 415 |
| 1982 | 3 | | | 131 | 134 |
| 1983 | 3 | 5 | | 746 | 754 |
| 1984 | | 29 | | 590 | 619 |
| 1985 | | 13 | | 498 | 511 |
| 1986 | 2 | 8 | 1 | 181 | 192 |
| 1987 | 1 | | | 92 | 93 |
| 1988 | 4 | | | 19 | 23 |
| 1989 | 11 | 23 | | 23 | 57 |
| 1990 | 11 | 4 | | 22 | 37 |
| 1991 | 5 | 2 | | 21 | 28 |
| 1992 | 6 | 3 | | 2 | 11 |
| 1993 | 2 | 9 | | 9 | 20 |
| 1994 | 5 | 1 | | 19 | 25 |
| 1995 | 3 | | | 13 | 16 |
| 1996 | 3 | 88 | 1 | 31 | 123 |
| 1997 | | | | 13 | 13 |
| 1998 | | | | 7 | 7 |
| 1999 | | | | | 0 |
| 2000 | | | | 4 | 4 |
| 2001 | | | | 73 | 73 |
| 2002 | | 4 | | 384 | 388 |
| 2003 | 1 | | | 397 | 398 |
| 2004 | 3 | | | 323 | 326 |
| 2005 | 5 | 1 | | 254 | 260 |
| 2006 | 2 | 8 | 3 | 20 | 33 |
| 2007 | 1 | 12 | 4 | 89 | 106 |
| 2008 | 10 | 6 | 1 | 143 | 160 |
| 2009 | 9 | 16 | 816 | 1278 | 2119 |

**Table 4.19.** Number of trips from which red snapper were aged from the headboat and charter fleets (combined) by year and state.

| Year | NC | SC | GA | FL | Total |
|---|---|---|---|---|---|
| 1977 | | 5 | | 17 | 22 |
| 1978 | 1 | 2 | 3 | 77 | 83 |
| 1979 | | 1 | | 31 | 32 |
| 1980 | 2 | 4 | | 30 | 36 |
| 1981 | 3 | | | 142 | 145 |
| 1982 | 1 | | | 55 | 56 |
| 1983 | 2 | 4 | | 167 | 173 |
| 1984 | | 19 | | 159 | 178 |
| 1985 | | 10 | | 151 | 161 |
| 1986 | 1 | 4 | 1 | 94 | 100 |
| 1987 | 1 | | | 63 | 64 |
| 1988 | 4 | | | 17 | 21 |
| 1989 | 5 | 17 | | 10 | 32 |
| 1990 | 6 | 3 | | 14 | 23 |
| 1991 | 5 | 2 | | 14 | 21 |
| 1992 | 4 | 2 | | 2 | 8 |
| 1993 | 2 | 6 | | 6 | 14 |
| 1994 | 3 | 1 | | 8 | 12 |
| 1995 | 2 | | | 6 | 8 |
| 1996 | 3 | 35 | 1 | 19 | 58 |
| 1997 | | | | 12 | 12 |
| 1998 | | | | 6 | 6 |
| 1999 | | | | | 0 |
| 2000 | | | | 3 | 3 |
| 2001 | | | | 27 | 27 |
| 2002 | | 4 | | 96 | 100 |
| 2003 | 1 | | | 80 | 81 |
| 2004 | 3 | | | 76 | 79 |
| 2005 | 2 | 1 | | 73 | 76 |
| 2006 | 2 | 8 | 3 | 13 | 26 |
| 2007 | 1 | 12 | 4 | 33 | 50 |
| 2008 | 6 | 4 | 1 | 41 | 52 |
| 2009 | 8 | 10 | 80 | 260 | 358 |

**Table 4.20.** Number of red snapper aged and number of trips from which red snapper were aged from the private fleets by year and state.

| | Number of Fish | | | Number of Trips | | |
|---|---|---|---|---|---|---|
| Year | FL | GA | Total | FL | GA | Total |
| 2004 | 3 | | 3 | 1 | | 0 |
| 2005 | | | 0 | | | 0 |
| 2006 | | | 0 | | | 1 |
| 2007 | 2 | | 2 | 1 | | 0 |
| 2008 | | | 0 | | | 0 |
| 2009 | 19 | 58 | 77 | 7 | 4 | 11 |

**Table 4.21.** Total MRFSS angler intercepts in Atlantic Ocean waters by state and year; and numbers (RS Intercepts) and percents (% RS) of MRFSS angler intercepts with red snapper catch or harvest - Florida

| | | Charter Mode | | | Private Boat Mode | | |
|---|---|---|---|---|---|---|---|
| YEAR | State | Total Intercepts | RS Intercepts | % RS | Total Intercepts | RS Intercepts | % RS |
| 1982 | FL | 249 | 1 | 0.40 | 1,825 | 14 | 0.77 |
| 1983 | FL | 1,024 | 84 | 8.20 | 1,303 | 2 | 0.15 |
| 1984 | FL | 1,427 | 114 | 7.99 | 1,679 | 18 | 1.07 |
| 1985 | FL | 727 | 70 | 9.63 | 1,440 | 19 | 1.32 |
| 1986 | FL | 741 | 73 | 9.85 | 3,355 | 13 | 0.39 |
| 1987 | FL | 315 | | 0.00 | 3,592 | 17 | 0.47 |
| 1988 | FL | 604 | 6 | 0.99 | 3,624 | 20 | 0.55 |
| 1989 | FL | 680 | 4 | 0.59 | 3,226 | 28 | 0.87 |
| 1990 | FL | 600 | | 0.00 | 2,974 | 6 | 0.20 |
| 1991 | FL | 625 | 2 | 0.32 | 3,646 | 11 | 0.30 |
| 1992 | FL | 1,127 | 36 | 3.19 | 6,559 | 17 | 0.26 |
| 1993 | FL | 668 | 2 | 0.30 | 5,768 | 26 | 0.45 |
| 1994 | FL | 661 | 3 | 0.45 | 6,658 | 28 | 0.42 |
| 1995 | FL | 648 | 1 | 0.15 | 6,116 | 25 | 0.41 |
| 1996 | FL | 718 | 1 | 0.14 | 6,998 | 13 | 0.19 |
| 1997 | FL | 965 | 1 | 0.10 | 6,985 | 11 | 0.16 |
| 1998 | FL | 1,241 | 3 | 0.24 | 8,000 | 26 | 0.33 |
| 1999 | FL | 1,258 | 31 | 2.46 | 11,033 | 87 | 0.79 |
| 2000 | FL | 1,621 | 61 | 3.76 | 10,763 | 93 | 0.86 |
| 2001 | FL | 2,519 | 100 | 3.97 | 11,946 | 116 | 0.97 |
| 2002 | FL | 3,078 | 143 | 4.65 | 12,338 | 93 | 0.75 |
| 2003 | FL | 2,553 | 104 | 4.07 | 11,305 | 79 | 0.70 |
| 2004 | FL | 1,895 | 90 | 4.75 | 9,731 | 98 | 1.01 |
| 2005 | FL | 2,069 | 85 | 4.11 | 9,697 | 63 | 0.65 |
| 2006 | FL | 1,813 | 69 | 3.81 | 12,095 | 80 | 0.66 |
| 2007 | FL | 1,694 | 51 | 3.01 | 11,019 | 114 | 1.03 |
| 2008 | FL | 1,319 | 49 | 3.71 | 9,779 | 147 | 1.50 |
| 2009 | FL | 1,030 | 22 | 2.14 | 9,031 | 132 | 1.46 |

**Table 4.21.** continued - Georgia

| | | Charter Mode | | | Private Boat Mode | | |
|---|---|---|---|---|---|---|---|
| YEAR | State | Total Intercepts | RS Intercepts | % RS | Total Intercepts | RS Intercepts | % RS |
| 1982 | GA | 19 | | 0.00 | 459 | | 0.00 |
| 1983 | GA | 121 | | 0.00 | 274 | 2 | 0.73 |
| 1984 | GA | 99 | 3 | 3.03 | 275 | | 0.00 |
| 1985 | GA | 275 | 2 | 0.73 | 1,550 | 7 | 0.45 |
| 1986 | GA | 373 | 4 | 1.07 | 1,774 | 2 | 0.11 |
| 1987 | GA | 548 | 1 | 0.18 | 2,448 | 3 | 0.12 |
| 1988 | GA | 261 | 3 | 1.15 | 1,207 | | 0.00 |
| 1989 | GA | 207 | 1 | 0.48 | 1,196 | 1 | 0.08 |
| 1990 | GA | 169 | | 0.00 | 425 | | 0.00 |
| 1991 | GA | 224 | 2 | 0.89 | 626 | 1 | 0.16 |
| 1992 | GA | 501 | 39 | 7.78 | 1,094 | 2 | 0.18 |
| 1993 | GA | 251 | 25 | 9.96 | 645 | | 0.00 |
| 1994 | GA | 311 | 16 | 5.14 | 586 | | 0.00 |
| 1995 | GA | 220 | 18 | 8.18 | 595 | | 0.00 |
| 1996 | GA | 243 | 10 | 4.12 | 776 | 1 | 0.13 |
| 1997 | GA | 275 | 2 | 0.73 | 917 | | 0.00 |
| 1998 | GA | 345 | 25 | 7.25 | 756 | | 0.00 |
| 1999 | GA | 279 | 30 | 10.75 | 658 | | 0.00 |
| 2000 | GA | 293 | 25 | 8.53 | 874 | | 0.00 |
| 2001 | GA | 243 | 14 | 5.76 | 1,003 | 1 | 0.10 |
| 2002 | GA | 260 | 7 | 2.69 | 918 | | 0.00 |
| 2003 | GA | 466 | 26 | 5.58 | 1,027 | | 0.00 |
| 2004 | GA | 474 | 55 | 11.60 | 985 | 8 | 0.81 |
| 2005 | GA | 489 | 39 | 7.98 | 805 | 1 | 0.12 |
| 2006 | GA | 513 | 57 | 11.11 | 753 | 2 | 0.27 |
| 2007 | GA | 483 | 28 | 5.80 | 834 | 6 | 0.72 |
| 2008 | GA | 554 | 45 | 8.12 | 772 | 9 | 1.17 |
| 2009 | GA | 497 | 35 | 7.04 | 783 | 2 | 0.26 |

**Table 4.21.** continued – North Carolina

| | | Charter Mode | | | Private Boat Mode | | |
|---|---|---|---|---|---|---|---|
| YEAR | State | Total Intercepts | RS Intercepts | % RS | Total Intercepts | RS Intercepts | % RS |
| 1982 | NC | 101 | | 0.00 | 770 | | 0.00 |
| 1983 | NC | 186 | | 0.00 | 386 | | 0.00 |
| 1984 | NC | 316 | 2 | 0.63 | 348 | | 0.00 |
| 1985 | NC | 237 | 7 | 2.95 | 590 | | 0.00 |
| 1986 | NC | 547 | 2 | 0.37 | 1,450 | | 0.00 |
| 1987 | NC | 1,941 | 21 | 1.08 | 3,471 | 7 | 0.20 |
| 1988 | NC | 1,668 | 23 | 1.38 | 3,916 | 4 | 0.10 |
| 1989 | NC | 2,433 | 21 | 0.86 | 4,637 | 4 | 0.09 |
| 1990 | NC | 2,163 | 15 | 0.69 | 5,643 | 2 | 0.04 |
| 1991 | NC | 2,714 | 12 | 0.44 | 5,212 | 1 | 0.02 |
| 1992 | NC | 2,604 | 14 | 0.54 | 4,446 | 2 | 0.04 |
| 1993 | NC | 2,688 | 5 | 0.19 | 4,584 | 2 | 0.04 |
| 1994 | NC | 4,574 | 21 | 0.46 | 6,274 | 2 | 0.03 |
| 1995 | NC | 4,033 | 17 | 0.42 | 6,093 | | 0.00 |
| 1996 | NC | 6,448 | 4 | 0.06 | 5,927 | 2 | 0.03 |
| 1997 | NC | 6,371 | | 0.00 | 6,083 | | 0.00 |
| 1998 | NC | 5,815 | 1 | 0.02 | 5,464 | 1 | 0.02 |
| 1999 | NC | 3,747 | 5 | 0.13 | 4,498 | | 0.00 |
| 2000 | NC | 4,357 | 3 | 0.07 | 4,534 | 3 | 0.07 |
| 2001 | NC | 4,311 | 10 | 0.23 | 6,849 | 2 | 0.03 |
| 2002 | NC | 3,792 | 12 | 0.32 | 5,115 | | 0.00 |
| 2003 | NC | 3,102 | 10 | 0.32 | 4,905 | | 0.00 |
| 2004 | NC | 2,986 | 1 | 0.03 | 5,151 | 1 | 0.02 |
| 2005 | NC | 2,679 | 1 | 0.04 | 4,880 | 2 | 0.04 |
| 2006 | NC | 2,553 | 3 | 0.12 | 6,949 | 2 | 0.03 |
| 2007 | NC | 2,249 | 1 | 0.04 | 5,635 | | 0.00 |
| 2008 | NC | 2,314 | 6 | 0.26 | 5,374 | | 0.00 |
| 2009 | NC | 1,905 | 8 | 0.42 | 4,798 | 3 | 0.06 |

**Table 4.21.** continued – South Carolina

| | | Charter Mode | | | Private Boat Mode | | |
|---|---|---|---|---|---|---|---|
| YEAR | State | Total Intercepts | RS Intercepts | % RS | Total Intercepts | RS Intercepts | % RS |
| 1989 | SC | 752 | 9 | 1.20 | 1,151 | 1 | 0.09 |
| 1990 | SC | 357 | 1 | 0.28 | 992 | | 0.00 |
| 1991 | SC | 230 | 4 | 1.74 | 528 | | 0.00 |
| 1992 | SC | 439 | | 0.00 | 1,390 | | 0.00 |
| 1993 | SC | 264 | | 0.00 | 958 | 2 | 0.21 |
| 1994 | SC | 276 | 1 | 0.36 | 840 | | 0.00 |
| 1995 | SC | 271 | | 0.00 | 985 | | 0.00 |
| 1996 | SC | 374 | 2 | 0.53 | 1,665 | | 0.00 |
| 1997 | SC | 413 | 14 | 3.39 | 1,964 | | 0.00 |
| 1998 | SC | 426 | 7 | 1.64 | 1,886 | 1 | 0.05 |
| 1999 | SC | 433 | 34 | 7.85 | 1,297 | 3 | 0.23 |
| 2000 | SC | 796 | 28 | 3.52 | 1,310 | 7 | 0.53 |
| 2001 | SC | 361 | 10 | 2.77 | 1,256 | | 0.00 |
| 2002 | SC | 279 | 4 | 1.43 | 1,103 | 2 | 0.18 |
| 2003 | SC | 263 | 10 | 3.80 | 493 | 2 | 0.41 |
| 2004 | SC | 410 | 9 | 2.20 | 1,036 | | 0.00 |
| 2005 | SC | 499 | 18 | 3.61 | 1,160 | | 0.00 |
| 2006 | SC | 427 | 6 | 1.41 | 1,172 | 1 | 0.09 |
| 2007 | SC | 584 | 11 | 1.88 | 1,180 | 1 | 0.08 |
| 2008 | SC | 598 | 13 | 2.17 | 1,295 | 2 | 0.15 |
| 2009 | SC | 484 | 10 | 2.07 | 1,338 | 3 | 0.22 |

**Table 4.22.** For-Hire recreational angler effort in the South Atlantic sub-region.

| Year | Charter Boat Mode (1981-85 = Party/Charter Boat Mode) Number of Angler-Trips (1986-2003 adjusted, FHS-ratios) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FL | | GA | | NC | | SC | | S. Atlantic Total | |
| | Number Trips | PSE | Number Trips | PSE | Number Trips | PSE | Number Trips | PSE | Number Trips | PSE |
| 1981 | 184,293 | 12.9 | 218 | 101.3 | 303,979 | 38.2 | 19,182 | 35.3 | 507,671 | 23.4 |
| 1982 | 433,888 | 11.1 | 26,037 | 32.1 | 282,247 | 19.9 | 76,877 | 40.6 | 819,048 | 9.8 |
| 1983 | 321,582 | 11.3 | 23,528 | 27.2 | 525,693 | 41.4 | 45,513 | 23.3 | 916,317 | 24.1 |
| 1984 | 402,050 | 12.3 | 30,312 | 22.7 | 286,190 | 16.2 | 123,433 | 23.3 | 841,985 | 8.8 |
| 1985 | 477,455 | 10.8 | 30,330 | 25.2 | 375,880 | 18.4 | 105,658 | 24.9 | 989,323 | 9.1 |
| 1986 | 355,365 | 22.7 | 38,530 | 43 | 536,544 | 26.8 | 90,654 | 26.5 | 1,021,092 | 16.4 |
| 1987 | 372,786 | 20.9 | 33,454 | 34.8 | 212,576 | 29.6 | 96,032 | 27.5 | 714,848 | 14.6 |
| 1988 | 496,631 | 19 | 52,256 | 39.4 | 190,185 | 23.6 | 281,299 | 27.9 | 1,020,371 | 13 |
| 1989 | 367,403 | 19.6 | 42,142 | 41.1 | 156,848 | 21.2 | 260,325 | 32.3 | 826,718 | 14.1 |
| 1990 | 232,142 | 16.3 | 15,062 | 65.6 | 123,367 | 23.4 | 130,856 | 30.4 | 501,428 | 12.6 |
| 1991 | 217,271 | 12.2 | 33,381 | 50.2 | 127,026 | 20.4 | 146,636 | 26 | 524,314 | 10.6 |
| 1992 | 243,543 | 10.9 | 34,897 | 28 | 143,661 | 18.6 | 185,038 | 27.4 | 607,138 | 10.5 |
| 1993 | 320,428 | 8.9 | 45,424 | 27.8 | 188,358 | 17.4 | 232,984 | 25.6 | 787,194 | 9.5 |
| 1994 | 379,235 | 8 | 64,182 | 29.6 | 292,303 | 16 | 254,409 | 17.7 | 990,129 | 7.5 |
| 1995 | 424,181 | 7.1 | 82,357 | 32.8 | 331,480 | 15.5 | 296,509 | 17 | 1,134,527 | 7.3 |
| 1996 | 452,686 | 8.1 | 69,248 | 29.7 | 364,147 | 16 | 374,985 | 18.8 | 1,261,065 | 8 |
| 1997 | 460,128 | 7.5 | 49,631 | 31.2 | 455,973 | 15.3 | 230,787 | 17.8 | 1,196,518 | 7.5 |
| 1998 | 389,157 | 6.5 | 31,253 | 32.5 | 448,074 | 12.9 | 144,631 | 19.5 | 1,013,115 | 6.9 |
| 1999 | 319,527 | 7.3 | 19,101 | 21.2 | 346,701 | 14 | 97,433 | 20.6 | 782,763 | 7.3 |
| 2000 | 238,008 | 6.5 | 11,873 | 20 | 282,812 | 16.8 | 68,773 | 18.8 | 601,465 | 8.6 |
| 2001 | 217,224 | 6.1 | 11,922 | 20.2 | 314,978 | 15.7 | 62,332 | 20.7 | 606,455 | 8.7 |
| 2002 | 190,302 | 6 | 17,191 | 20.5 | 303,956 | 15.1 | 59,931 | 17 | 571,380 | 8.5 |
| 2003 | 186,678 | 9.4 | 22,413 | 21.3 | 260,191 | 17.5 | 71,310 | 21.3 | 540,592 | 9.5 |
| 2004 | 198,004 | 8.3 | 18,511 | 17.9 | 178,335 | 6.7 | 39,279 | 12.8 | 434,129 | 4.9 |
| 2005 | 200,910 | 6 | 25,081 | 10.8 | 253,162 | 10.3 | 28,889 | 15.9 | 508,042 | 5.7 |
| 2006 | 173,465 | 4.8 | 28,003 | 9 | 229,179 | 6.6 | 28,592 | 23.7 | 459,239 | 4.1 |
| 2007 | 177,725 | 5.2 | 26,302 | 10.6 | 212,284 | 7.3 | 84,307 | 15.1 | 500,619 | 4.4 |
| 2008 | 160,530 | 5.8 | 17,005 | 10 | 189,757 | 7.8 | 71,712 | 13.2 | 439,003 | 4.6 |
| 2009 | 179,654 | 5.9 | 16,193 | 10.1 | 146,331 | 6.1 | 79,561 | 13.2 | 421,738 | 4.1 |

**Table 4.23.** Private / Rental boat recreational angler effort in the South Atlantic sub-region.

| | Private/Rental Boat Mode Number of Angler-Trips (x1000) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FL | | GA | | NC | | SC | | S. Atlantic Total | |
| Year | Number Trips | PSE | Number Trips | PSE | Number Trips | PSE | Number Trips | PSE | Number Trips | PSE |
| 1981 | 1,973 | 8.4 | 119 | 25 | 617 | 12.1 | 333 | 15.7 | 3,042 | 6.3 |
| 1982 | 2,975 | 8.1 | 284 | 13.9 | 1,227 | 12.8 | 455 | 14 | 4,941 | 6 |
| 1983 | 3,482 | 7.6 | 186 | 25.1 | 1,436 | 9.4 | 619 | 17.4 | 5,724 | 5.6 |
| 1984 | 4,337 | 6.5 | 195 | 17.3 | 1,395 | 12.5 | 480 | 13.5 | 6,406 | 5.3 |
| 1985 | 4,357 | 8.2 | 199 | 17.3 | 1,182 | 10.2 | 549 | 12.7 | 6,287 | 6.1 |
| 1986 | 4,380 | 6.7 | 372 | 12.1 | 1,012 | 10.8 | 719 | 12.4 | 6,485 | 5.1 |
| 1987 | 5,045 | 4.8 | 449 | 11.6 | 1,374 | 4.9 | 887 | 10.5 | 7,754 | 3.5 |
| 1988 | 5,087 | 4 | 416 | 10.4 | 1,508 | 4.5 | 963 | 8.9 | 7,974 | 3 |
| 1989 | 4,883 | 5 | 410 | 13.7 | 1,273 | 5.5 | 507 | 14 | 7,073 | 3.8 |
| 1990 | 3,976 | 4.1 | 400 | 14.9 | 1,455 | 4.9 | 550 | 12.3 | 6,382 | 3.1 |
| 1991 | 4,738 | 3.7 | 356 | 17.5 | 1,151 | 5.2 | 977 | 11.4 | 7,222 | 3.1 |
| 1992 | 4,719 | 2.3 | 335 | 8.9 | 1,368 | 3.4 | 746 | 8.6 | 7,168 | 1.9 |
| 1993 | 4,162 | 2.3 | 440 | 9.2 | 1,436 | 3.7 | 808 | 7.9 | 6,846 | 1.9 |
| 1994 | 5,336 | 2 | 479 | 10 | 1,484 | 3.6 | 967 | 8.6 | 8,266 | 1.8 |
| 1995 | 5,242 | 2.1 | 432 | 8.3 | 1,315 | 3.3 | 677 | 7.8 | 7,667 | 1.8 |
| 1996 | 5,057 | 2.5 | 296 | 9.8 | 1,391 | 3.9 | 648 | 6.9 | 7,393 | 2 |
| 1997 | 5,622 | 2.5 | 352 | 9.8 | 1,570 | 3.7 | 732 | 5.3 | 8,276 | 1.9 |
| 1998 | 4,890 | 2.9 | 345 | 9.9 | 1,638 | 4.1 | 661 | 5.9 | 7,535 | 2.2 |
| 1999 | 4,196 | 3 | 292 | 11.1 | 1,861 | 4.3 | 587 | 7.3 | 6,935 | 2.3 |
| 2000 | 5,753 | 3 | 435 | 10.5 | 2,224 | 4.6 | 707 | 8.6 | 9,119 | 2.4 |
| 2001 | 5,994 | 3 | 449 | 14.9 | 2,169 | 4.2 | 954 | 8.2 | 9,565 | 2.4 |
| 2002 | 5,430 | 2.9 | 338 | 10.2 | 1,941 | 4.3 | 557 | 7.4 | 8,266 | 2.3 |
| 2003 | 6,212 | 3 | 549 | 11 | 2,181 | 4.5 | 1,021 | 8.3 | 9,963 | 2.3 |
| 2004 | 5,313 | 3.5 | 442 | 11.9 | 2,543 | 4.4 | 1,070 | 8.7 | 9,369 | 2.6 |
| 2005 | 6,230 | 3.5 | 501 | 10.5 | 2,354 | 4.2 | 989 | 7.8 | 10,073 | 2.6 |
| 2006 | 6,503 | 2.9 | 472 | 9.5 | 2,656 | 4.2 | 1,118 | 6.7 | 10,749 | 2.2 |
| 2007 | 8,317 | 2.9 | 553 | 7.9 | 2,784 | 4.4 | 1,483 | 6.3 | 13,137 | 2.2 |
| 2008 | 6,451 | 3 | 747 | 8.2 | 2,550 | 4.5 | 1,260 | 7.6 | 11,009 | 2.3 |
| 2009 | 5,401 | 3.2 | 503 | 9 | 2,032 | 4.6 | 1,051 | 6.2 | 8,988 | 2.4 |

**Table 4.24.** South Atlantic headboat estimated angler days 1981-2009.

| Year | NC | SC | GA\NEFL | SEFL | Grand Total |
|---|---|---|---|---|---|
| 1981 | 19372 | 59030 | 72069 | 226456 | 376927 |
| 1982 | 26939 | 67539 | 66961 | 226172 | 387611 |
| 1983 | 23830 | 65713 | 83499 | 194364 | 367406 |
| 1984 | 28865 | 67313 | 95234 | 193760 | 385172 |
| 1985 | 31346 | 66001 | 94446 | 186398 | 378191 |
| 1986 | 31187 | 67227 | 113101 | 203960 | 415475 |
| 1987 | 35261 | 78806 | 114144 | 218897 | 447108 |
| 1988 | 42421 | 76468 | 109156 | 192618 | 420663 |
| 1989 | 38678 | 62708 | 102920 | 213944 | 418250 |
| 1990 | 43240 | 57151 | 98234 | 224661 | 423286 |
| 1991 | 40936 | 67982 | 85111 | 194911 | 388940 |
| 1992 | 41177 | 61790 | 90810 | 173714 | 367491 |
| 1993 | 42785 | 64457 | 74494 | 162478 | 344214 |
| 1994 | 36693 | 63231 | 65745 | 177035 | 342704 |
| 1995 | 40294 | 61739 | 59104 | 142507 | 303644 |
| 1996 | 35142 | 54929 | 47236 | 152617 | 289924 |
| 1997 | 37189 | 60147 | 52756 | 120510 | 270602 |
| 1998 | 37399 | 61342 | 51790 | 103551 | 254082 |
| 1999 | 31596 | 55499 | 56770 | 107042 | 250907 |
| 2000 | 31323 | 40291 | 59771 | 122478 | 253863 |
| 2001 | 31779 | 49263 | 55795 | 107592 | 244429 |
| 2002 | 27601 | 42467 | 48911 | 102635 | 221614 |
| 2003 | 22998 | 36556 | 52795 | 92216 | 204565 |
| 2004 | 27255 | 50461 | 50544 | 123157 | 251417 |
| 2005 | 31573 | 34036 | 47778 | 123300 | 236687 |
| 2006 | 25730 | 56070 | 48943 | 126607 | 257350 |
| 2007 | 28997 | 60725 | 53759 | 103386 | 246867 |
| 2008 | 17156 | 47285 | 52338 | 71593 | 188372 |
| 2009 | 19463 | 40916 | 66442 | 66971 | 196792 |

## 4.12 Figures

**Figure 4.1a** Estimated red snapper landings (numbers) time series for recreational private, for-hire and commercial (handline) sectors. Pre-1981 recreational data was estimated from a ratio with commercial landings (see text for description). For-hire estimates include both CH and HB.

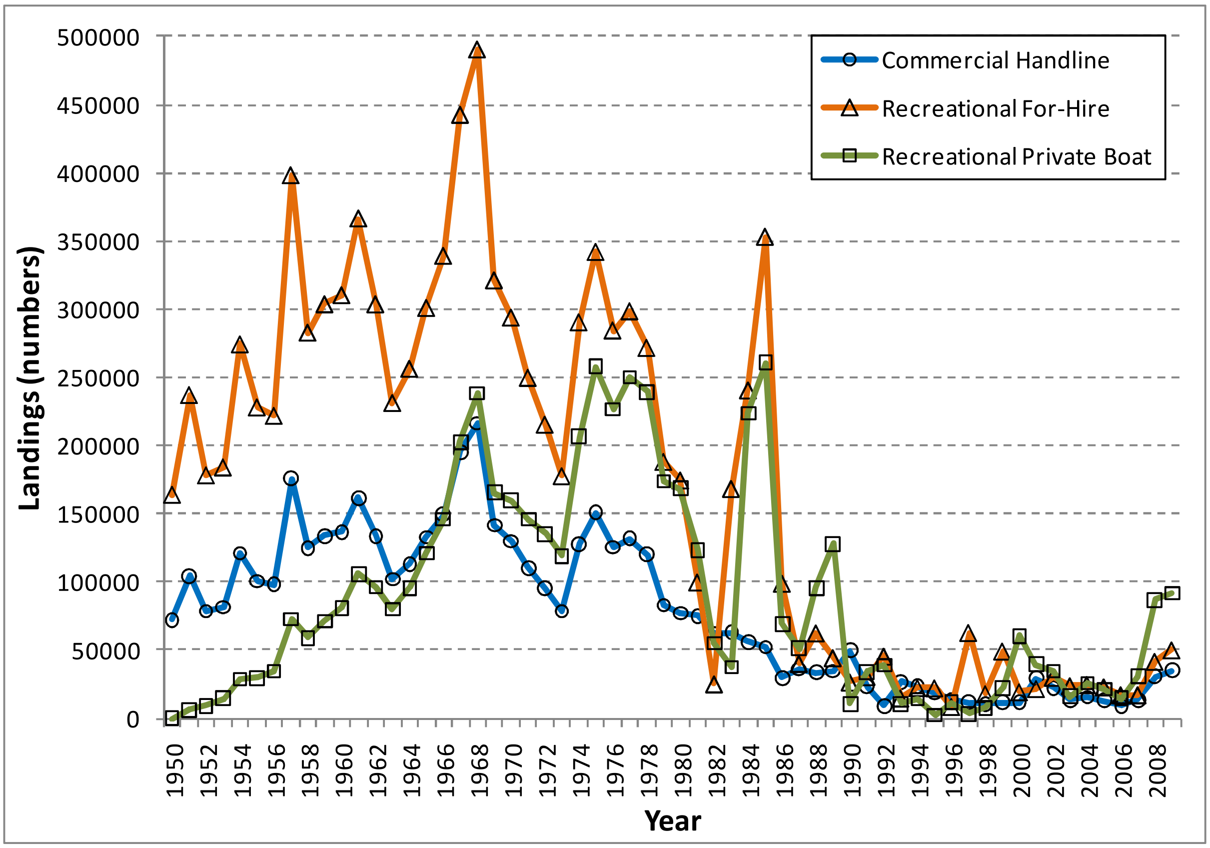


**Figure 4.1b.** Estimated historic red snapper landings (numbers) from both the ratio method and the adjusted SWAS.

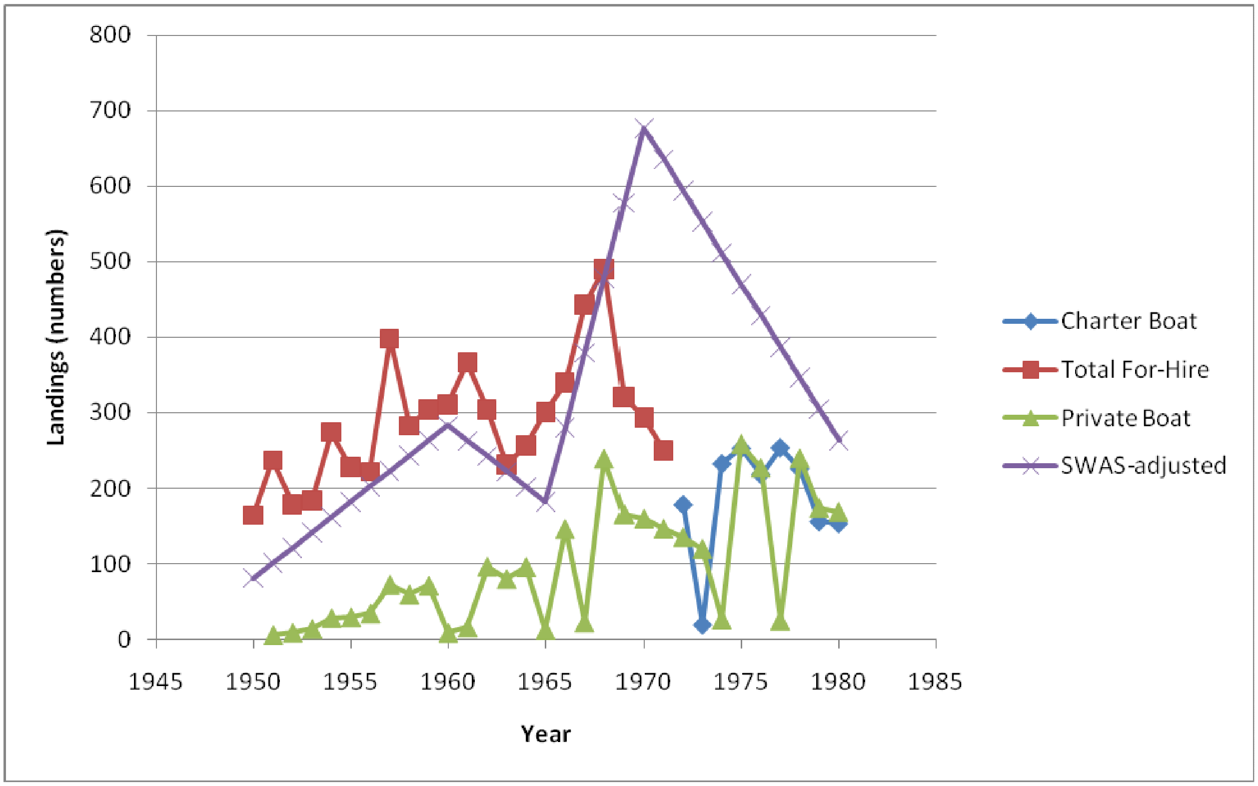


**Figure 4.2.** Red snapper CPUE and HPUE for SCDNR charter boat logbook data, 1993-2009.

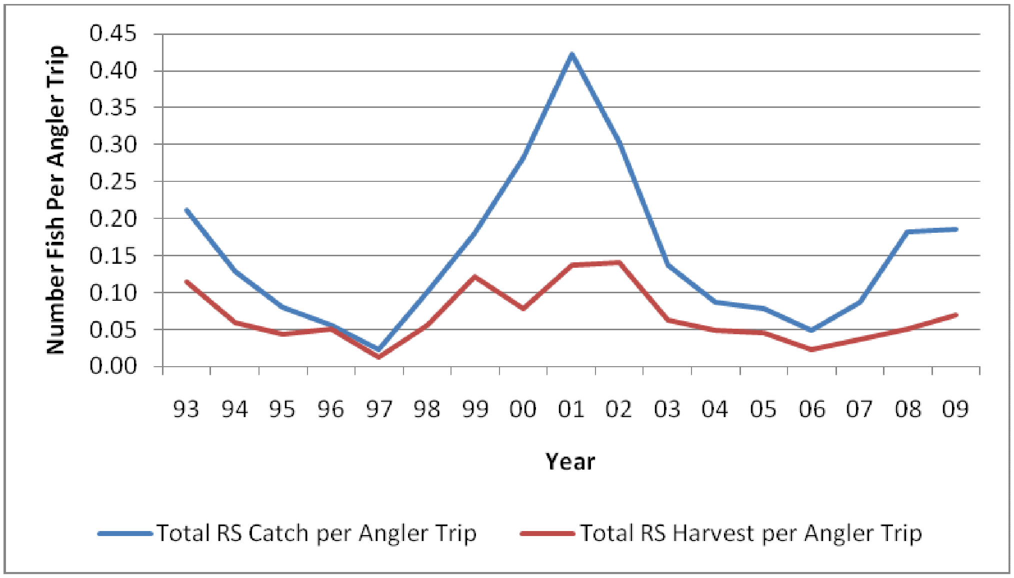



**Figure 4.3.** Percent of red snapper released for SCDNR charter boat logbook data, 1993-2009.

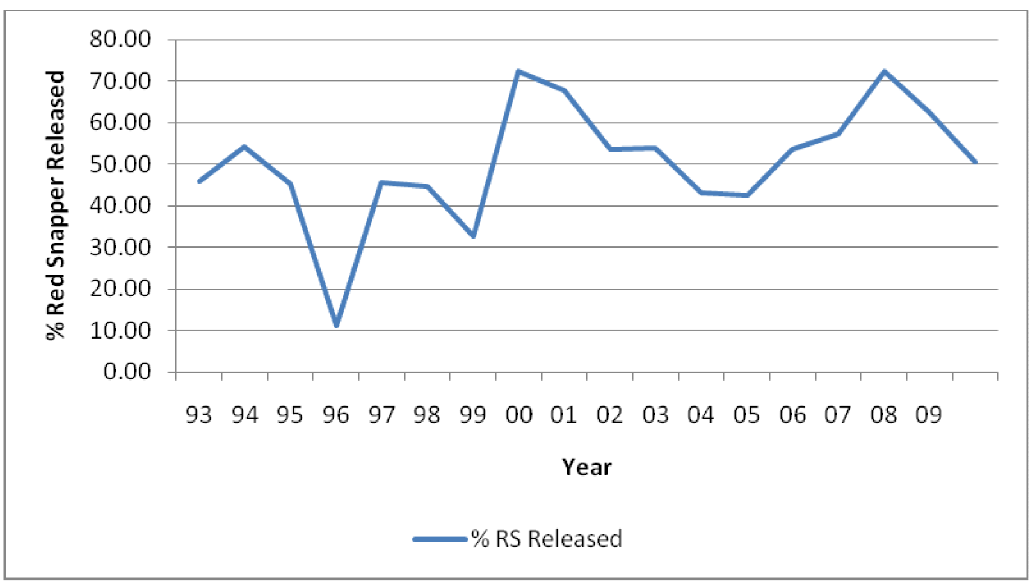


**Figure 4.4.** Percent of SC charter boat trips with at least one red snapper caught per trip.

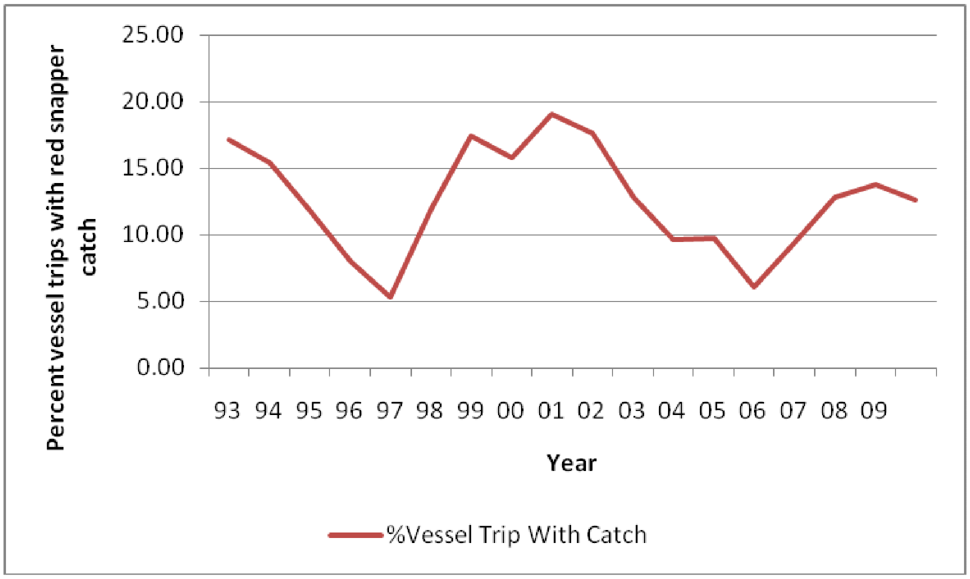



**Figure 4.5.** Comparison of SC red snapper total catch from MRFSS charter mode, NMFS headboat logbook, and SCDNR charterboat logbook program, 1991 – 2009.

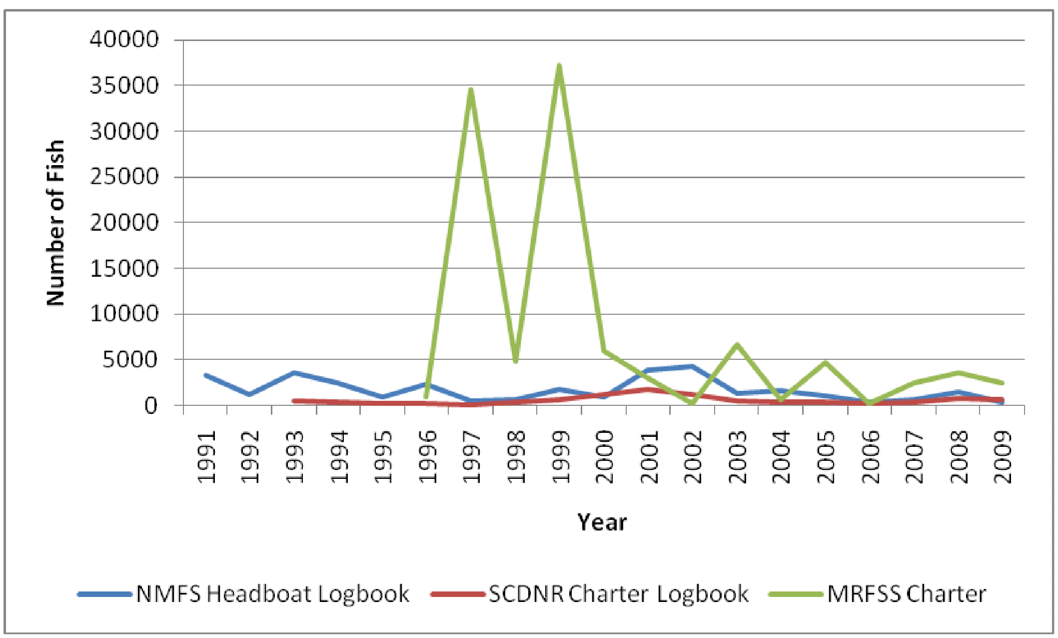


**Figure 4.6.** Percent red snapper discards in the recreational fishery 2004-2009.

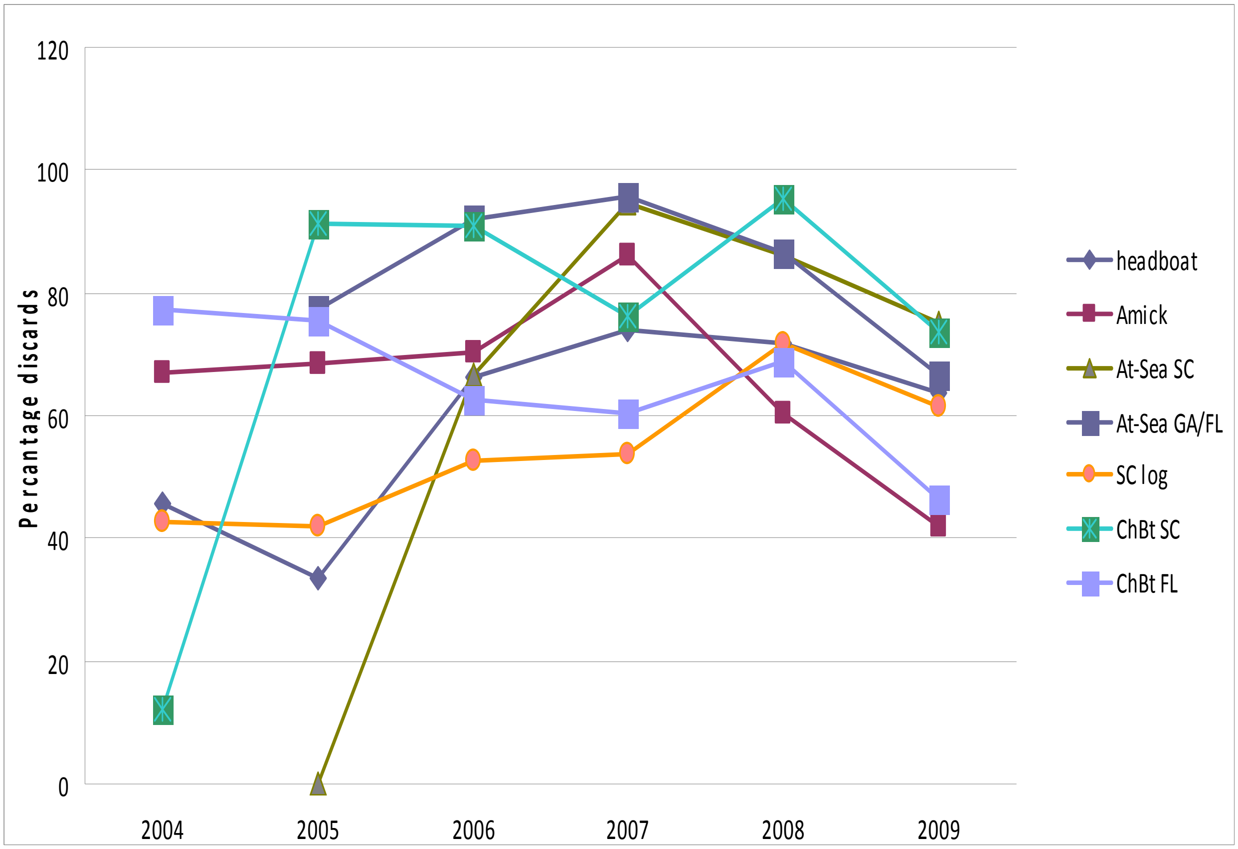


**Figure 4.7.** Proportion of red snapper samples by reported depths of capture for the charter boat, headboat, and private boat recreational sectors.

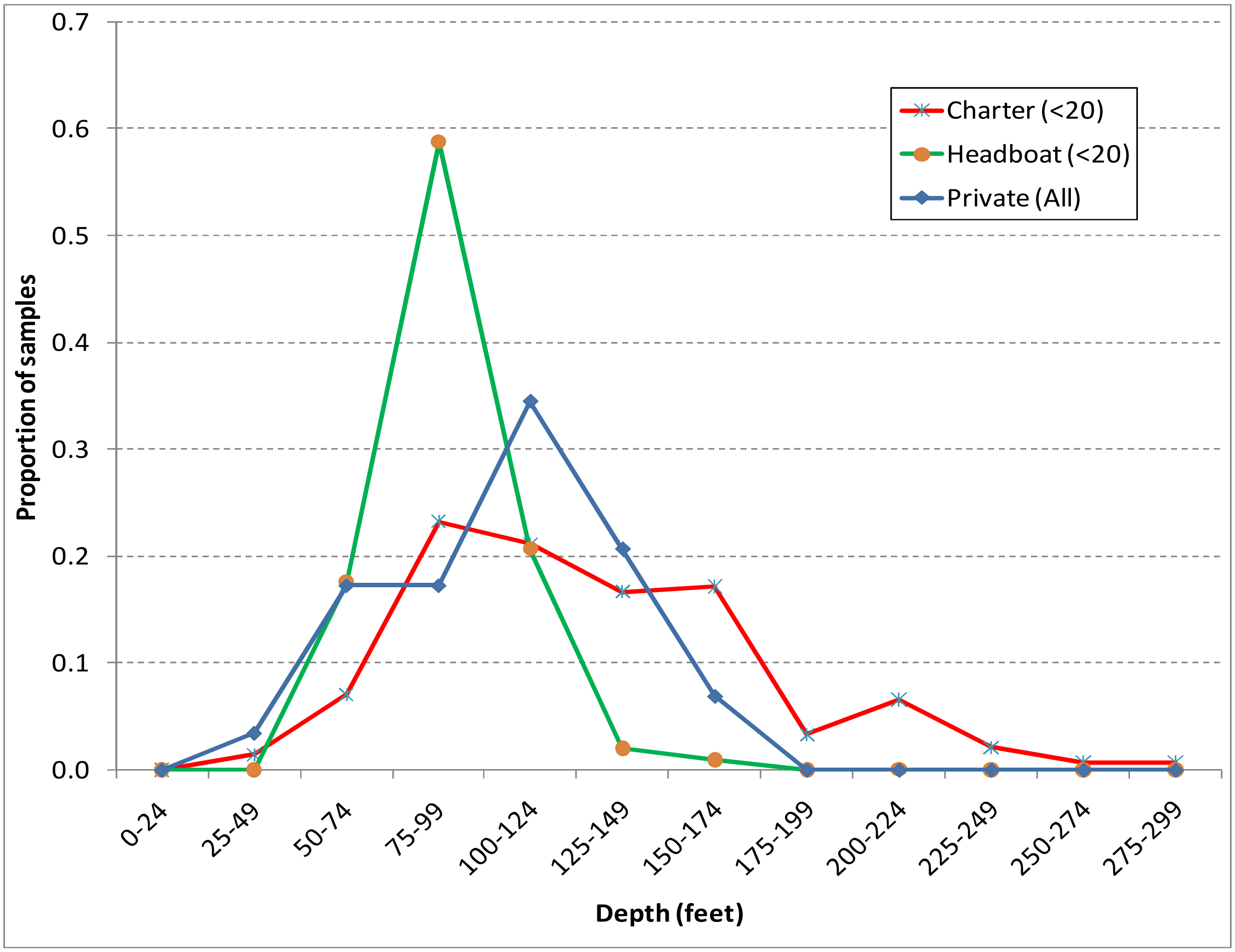


**Figure 4.8.** Headboat and MRFSS Charter combined length composition 1972-2009 .

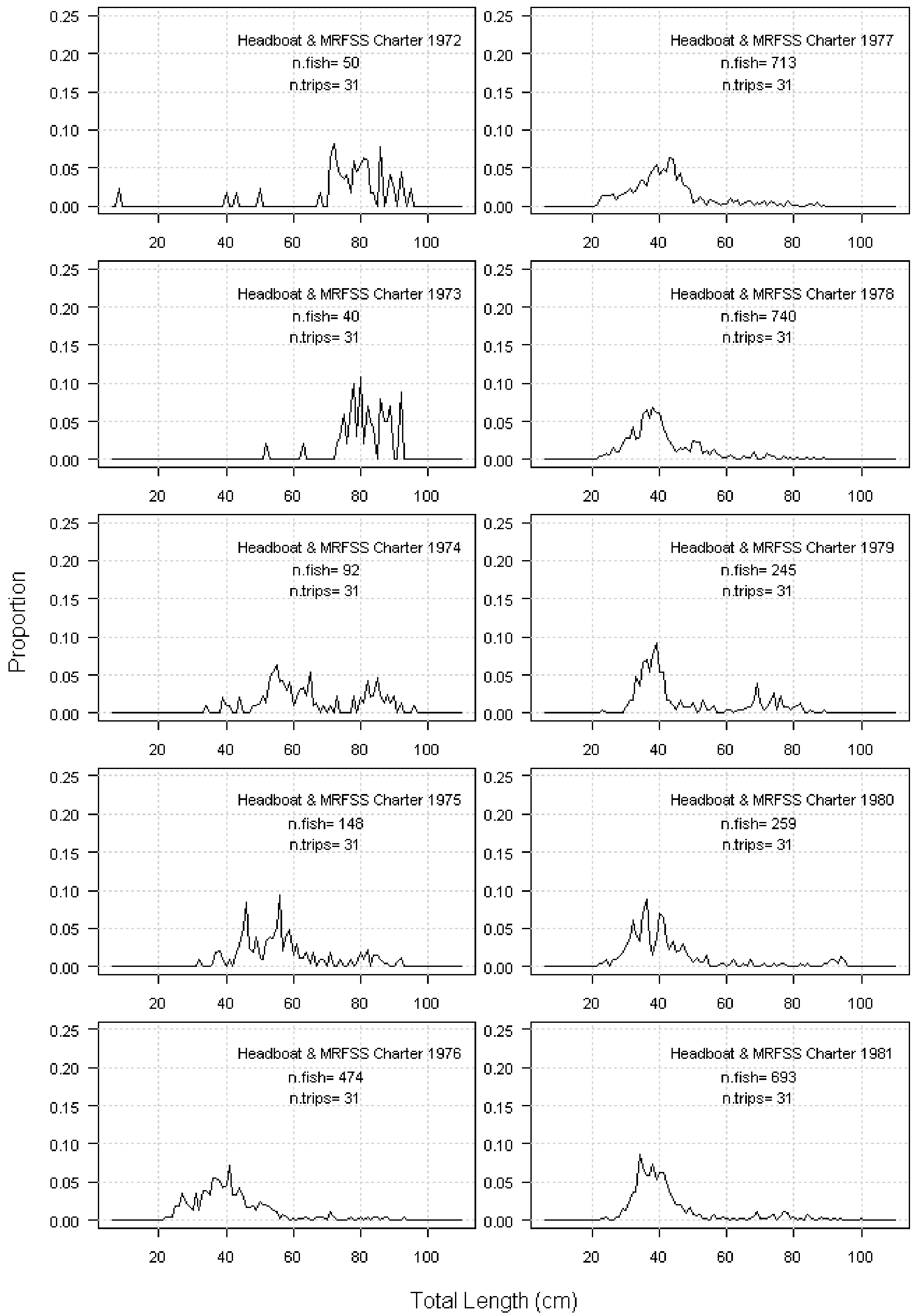


**Figure 4.8.** continued

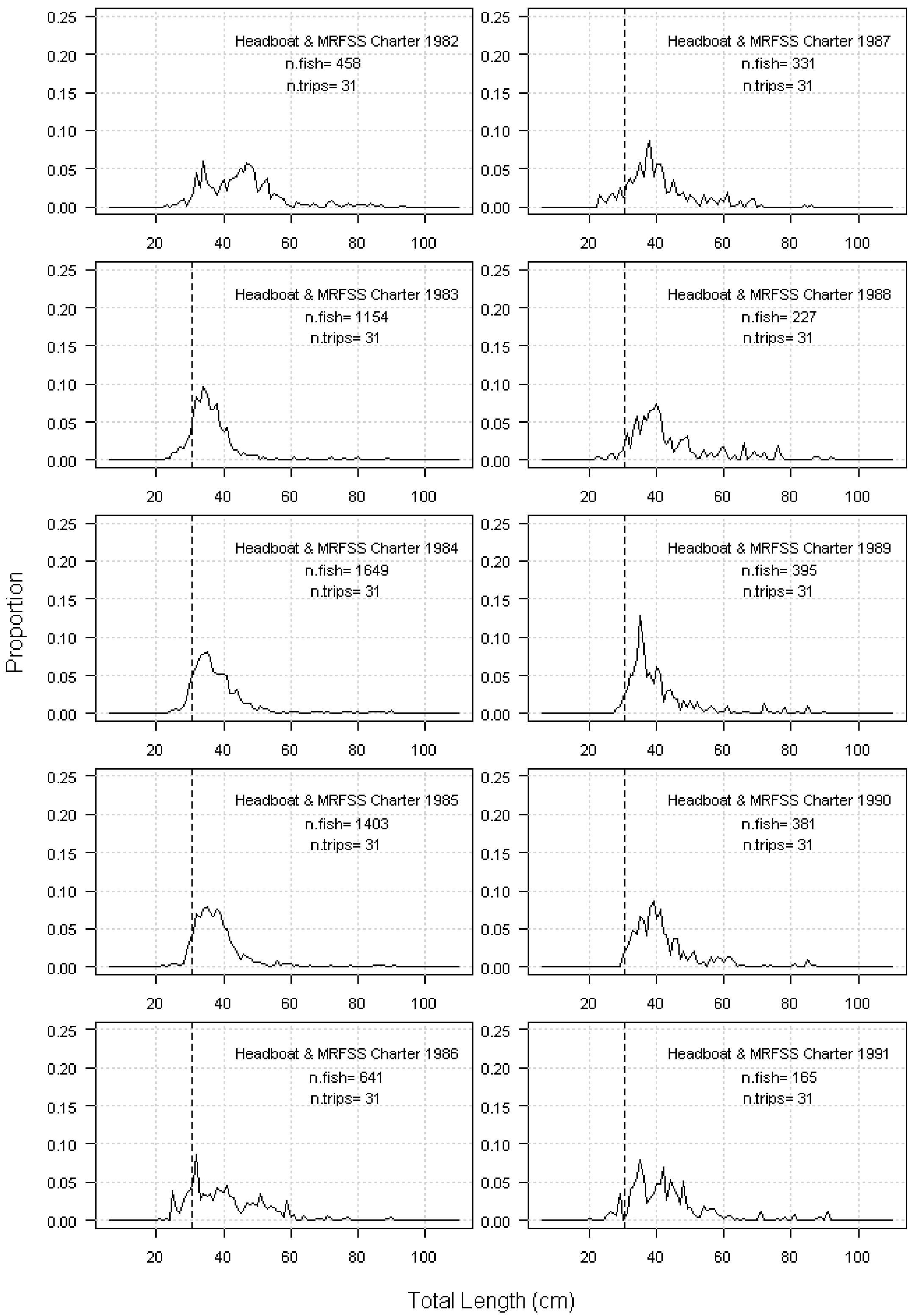


**Figure 4.8.** continued.

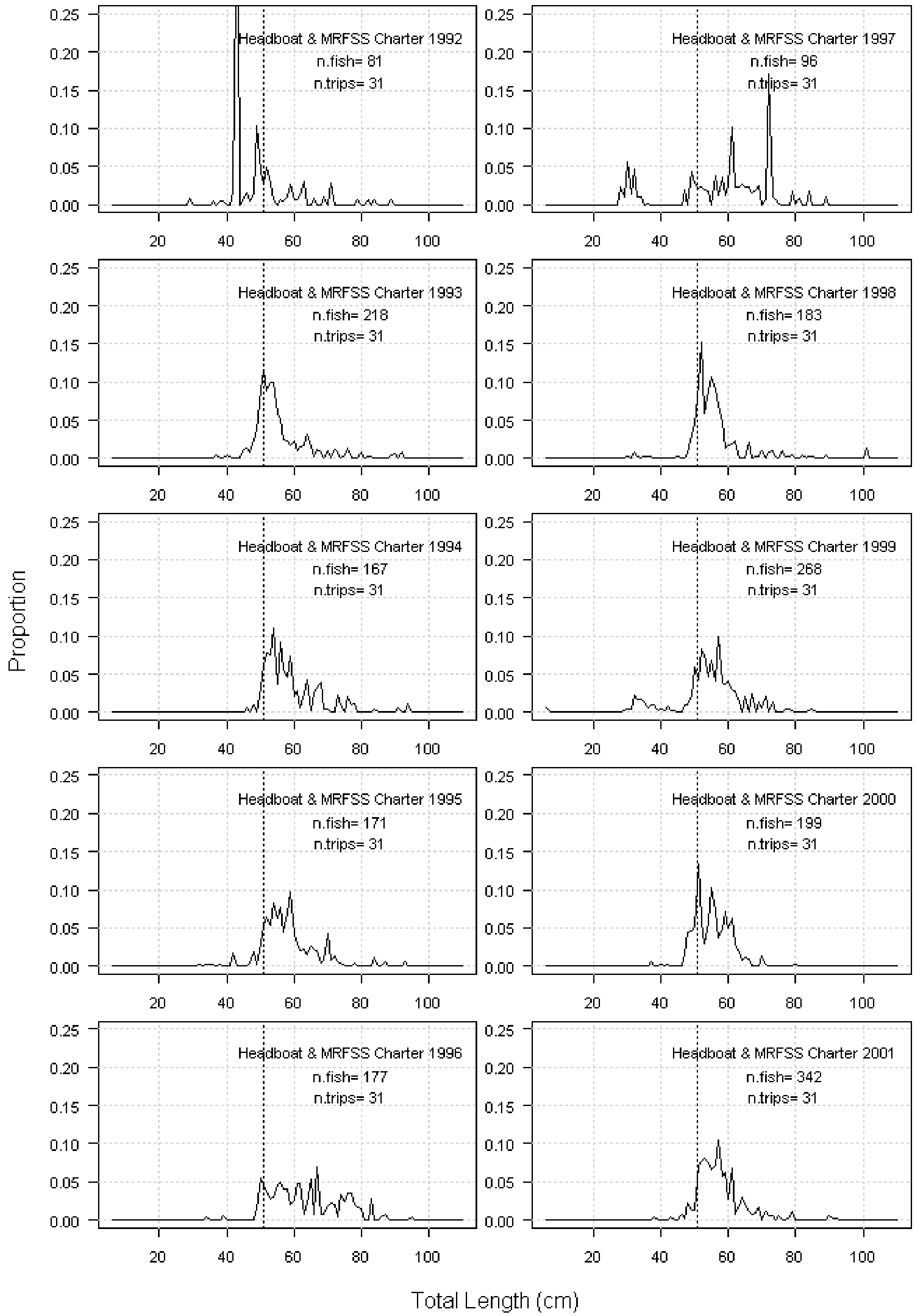


**Figure 4.8.** (continued).

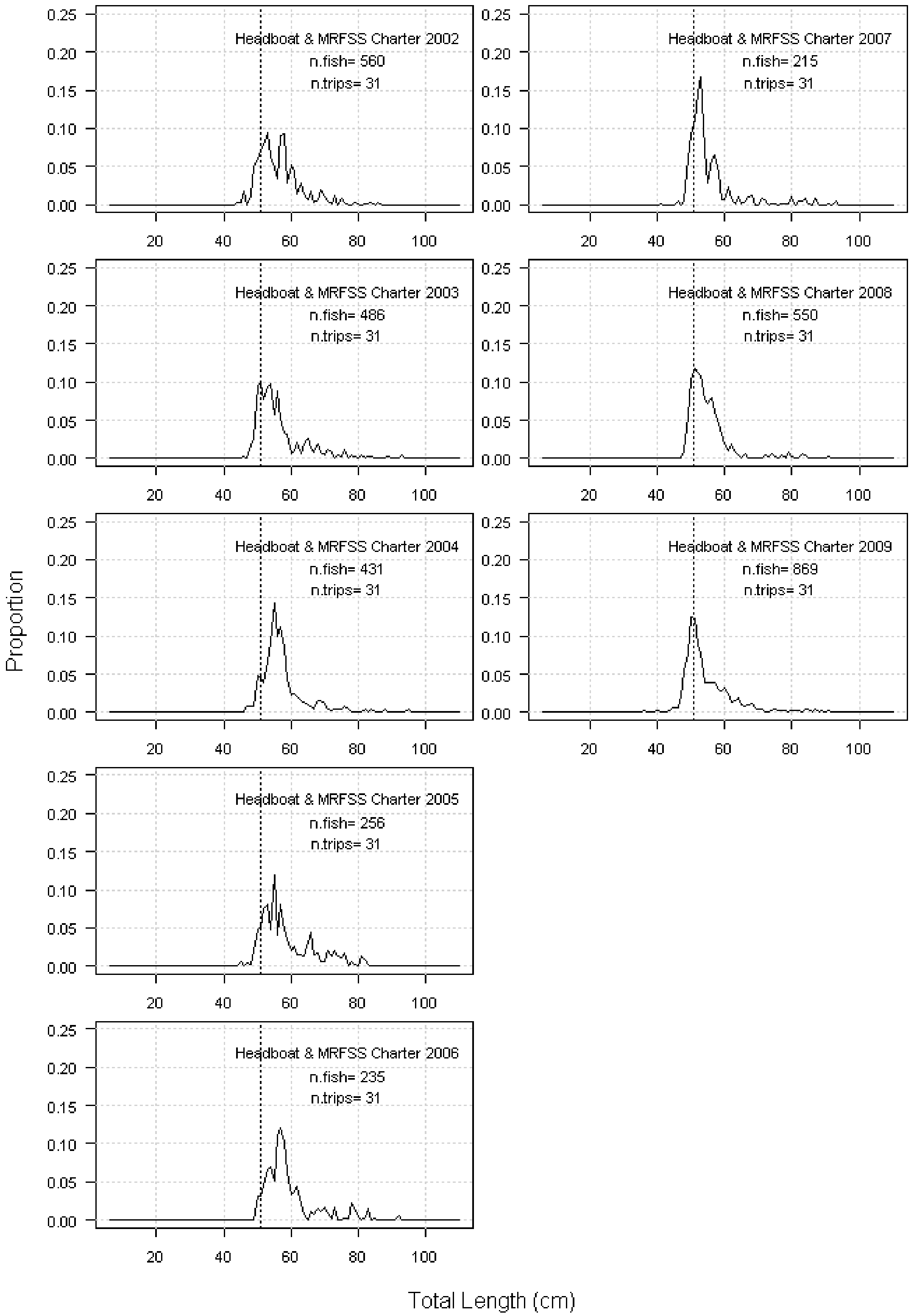


**Figure 4.9.** Private fleet length composition from the MRFSS 1981-2009.

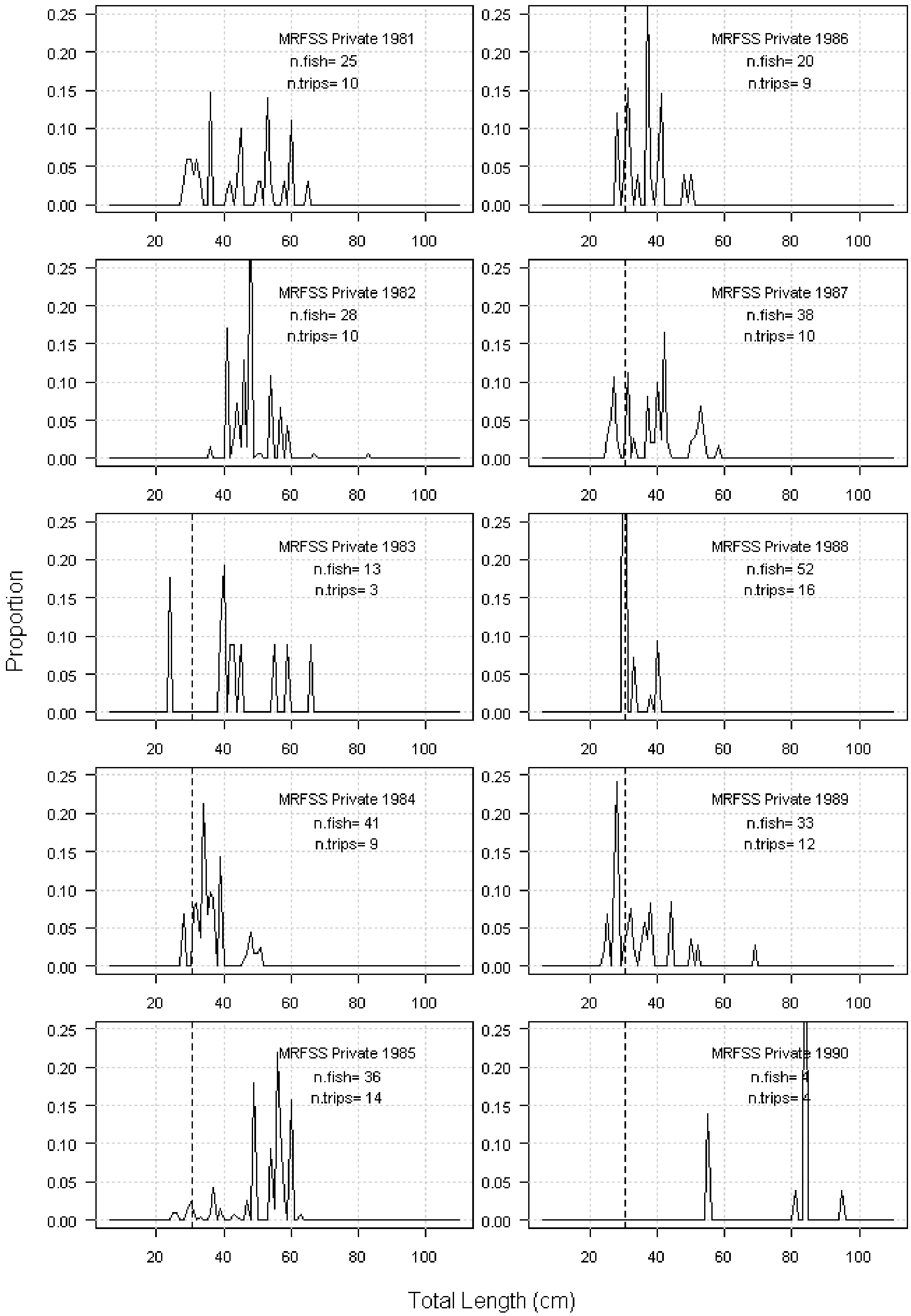


**Figure 4.9.** continued.

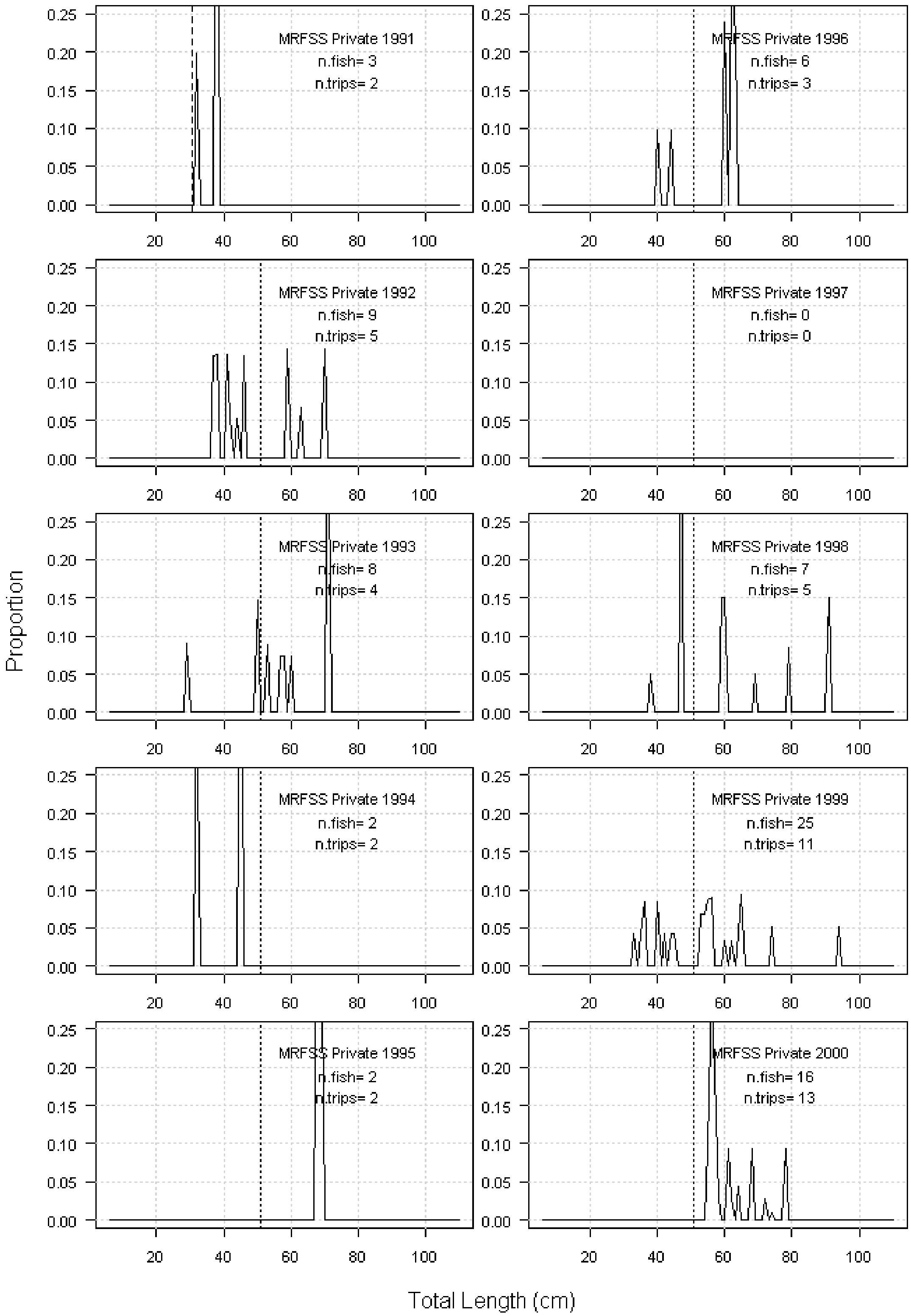


**Figure 4.9.** continued.

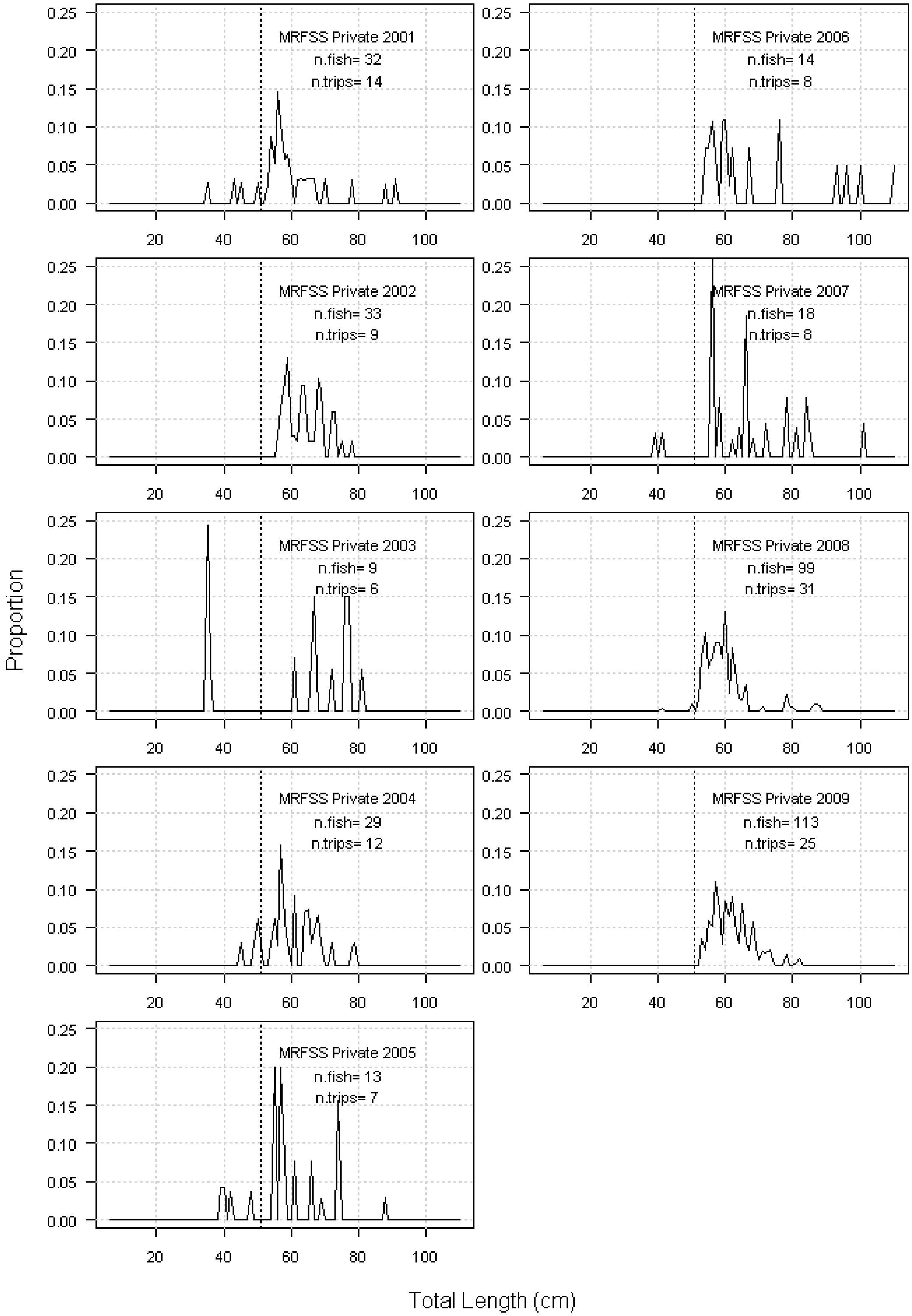


**Figure 4.10.** Headboat and MRFSS Charter combined age composition 1977-2009 and private fleet age composition from 2004, 2007, and 2009. Ages are plotted to 20 years

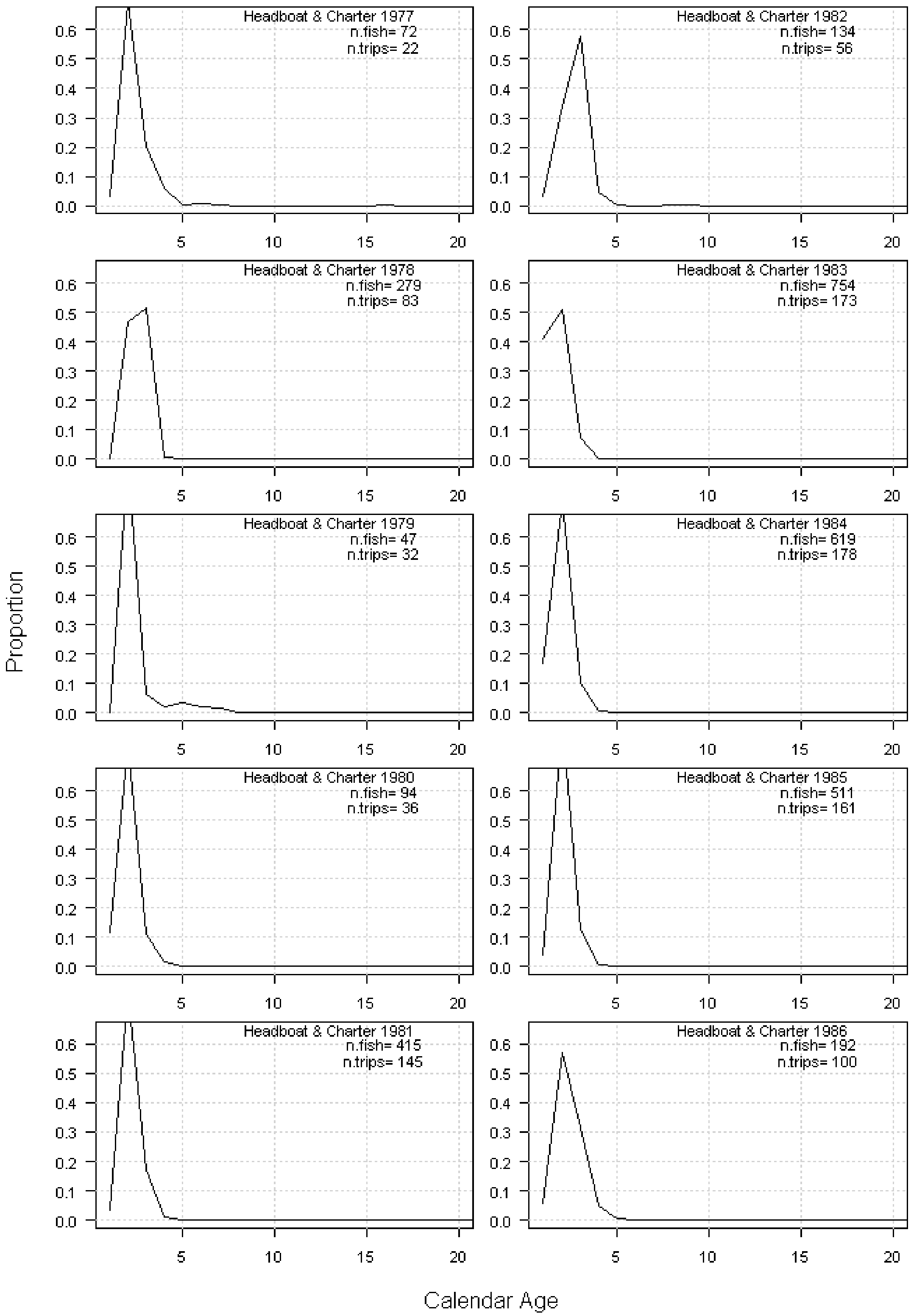


**Figure 4.10.** continued.

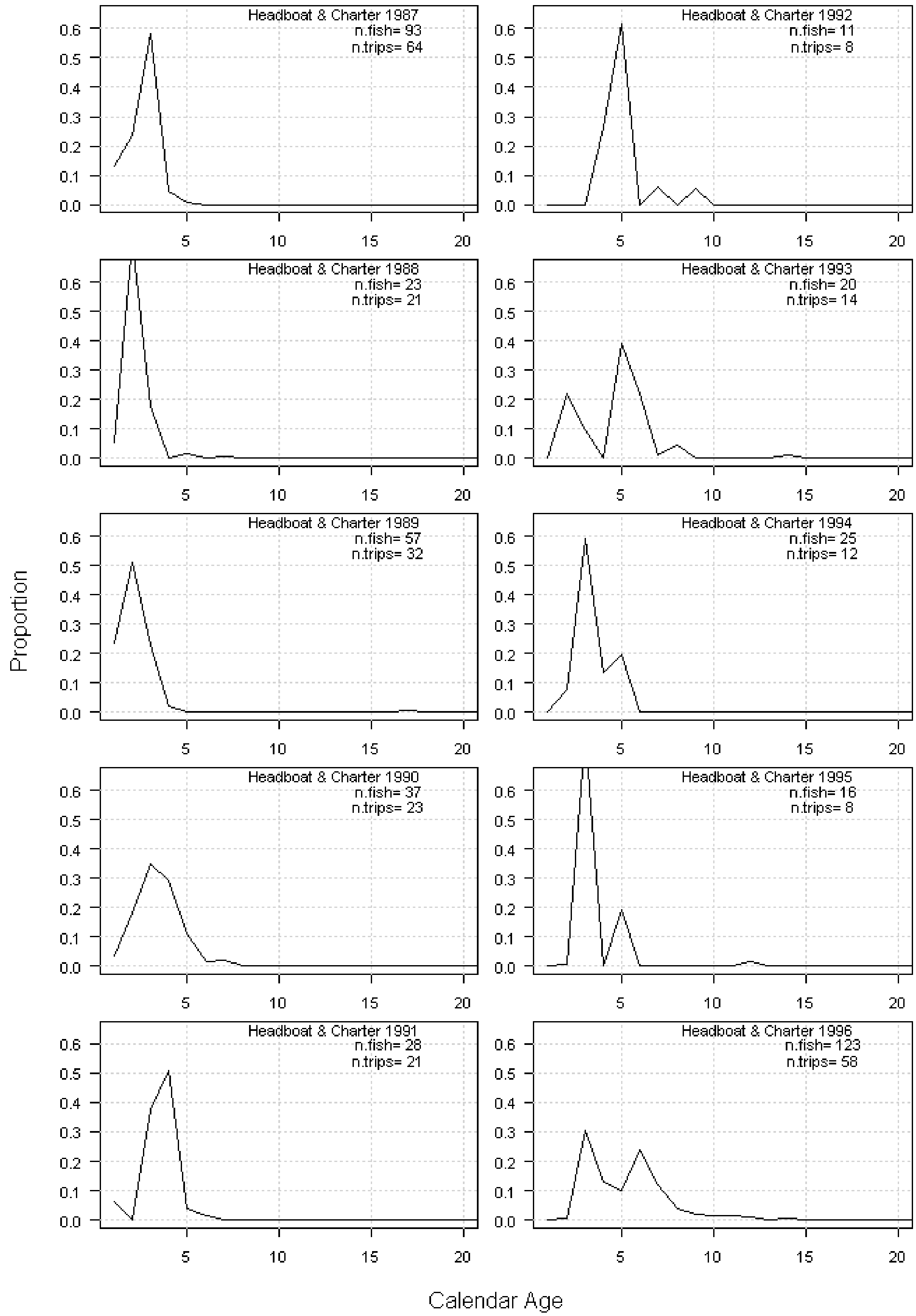


**Figure 4.10.** continued.

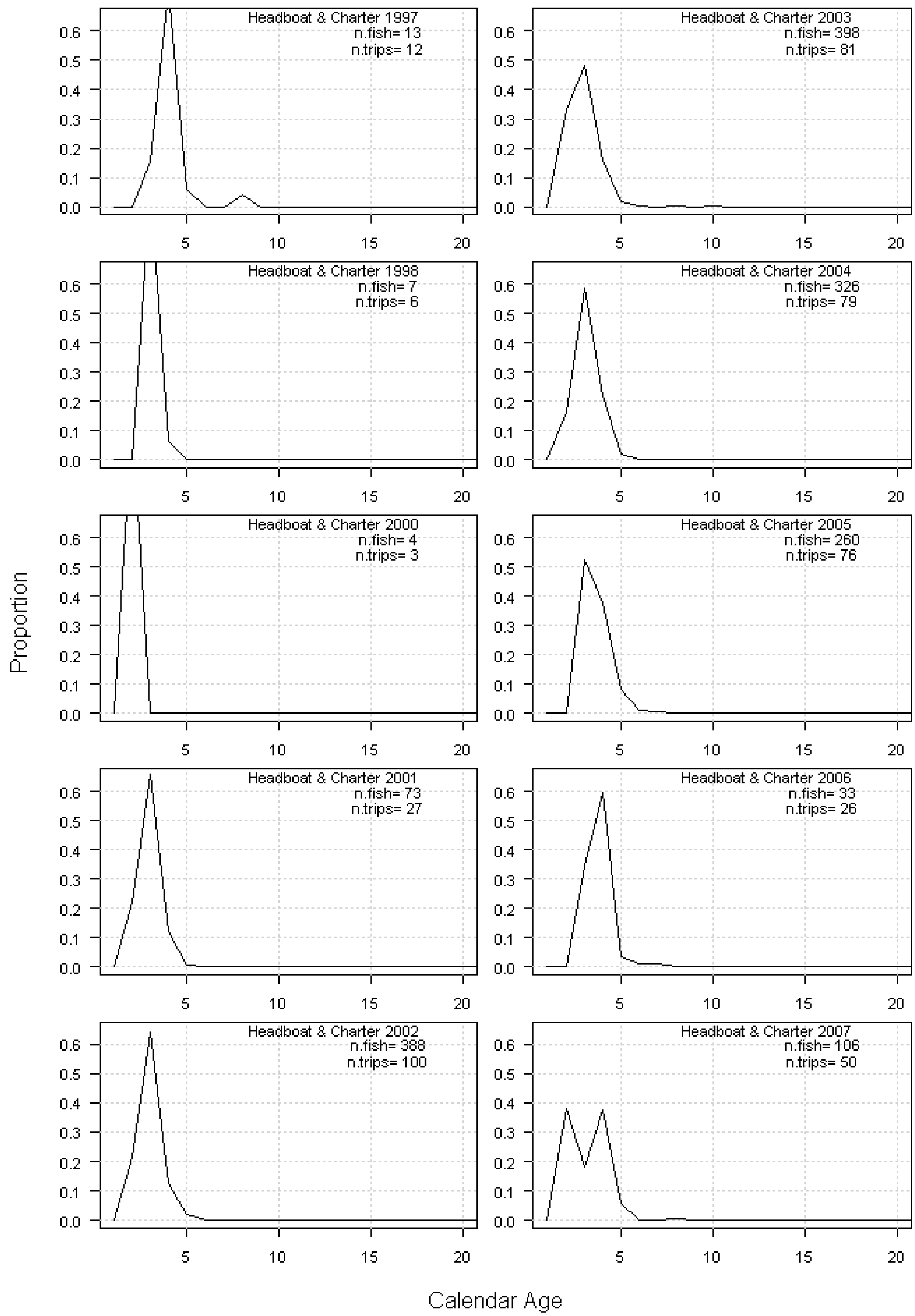
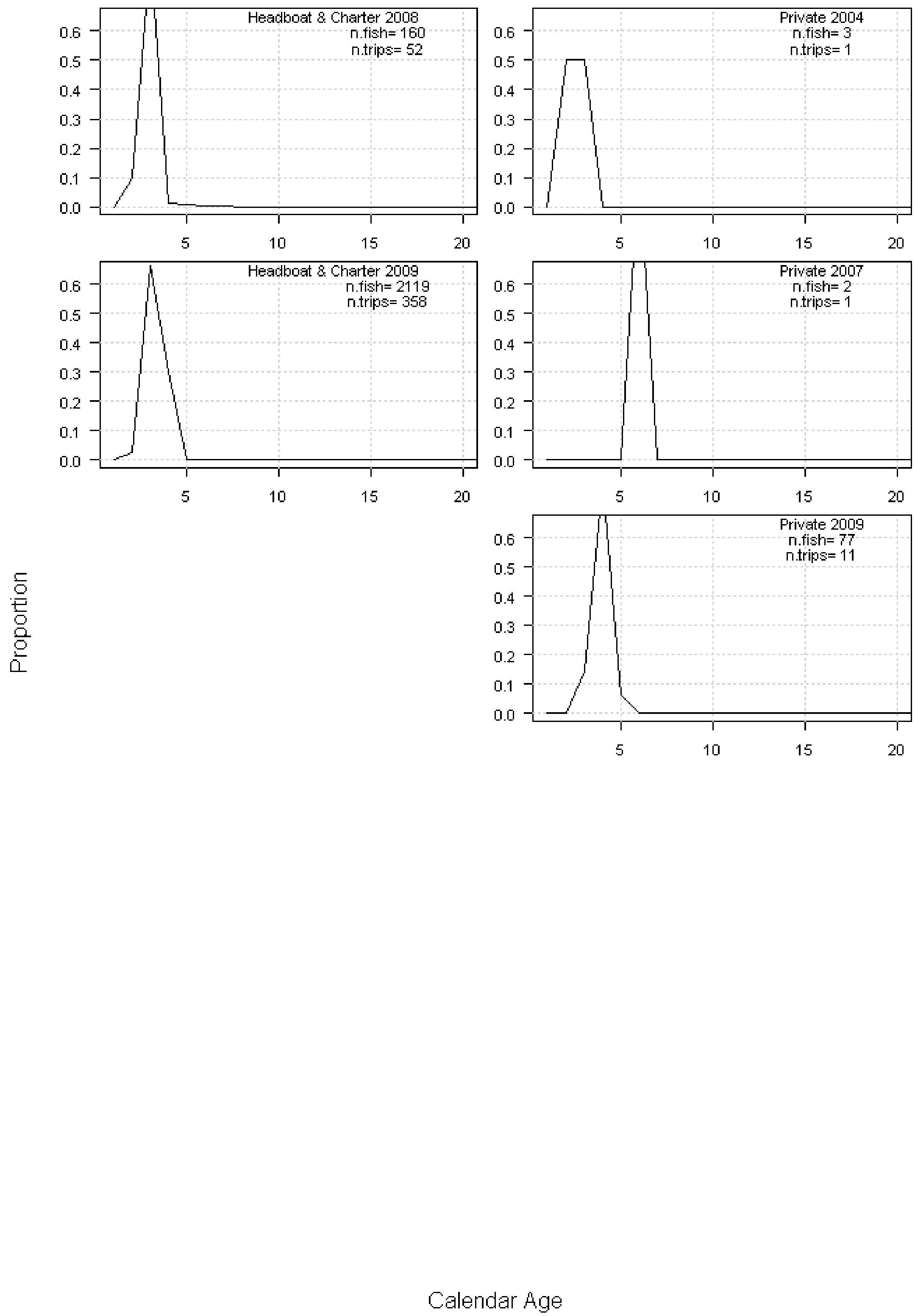


**Figure 4.10.** Continued.



# 5. Measures of Population Abundance

## 5.1 Overview

Several indices of abundance were considered for use in the South Atlantic red snapper assessment model. These indices are listed in Table 5.1.1, with pros and cons of each in Table 5.1.2. The possible indices came from fishery independent and fishery dependent data. The DW recommended the use of three fishery dependent indices (recreational headboat index, commercial logbook index, and headboat observer discards index; Tables 5.1.1 and 5.1.2). The discard index from headboat observers was not available prior to the DW and, although explored by the indices group, could not be standardized during the DW. Thus, the indices work group recommended that the assessment panel consider use of that index more fully. The group's recommendation is fully detailed below.

**Group membership**

Membership of this DW working group included Julie DeFilippi, Brian Linton (Rapporteur), Amy Schueller (Work group leader), Kyle Shertzer, Paul Spencer, and Jessica Stephen. Several other participants of the data workshop also participated in the indices work group discussions throughout the week.

## 5.2 Review of Working Papers

The working group reviewed a number of working papers describing index construction, including: SEDAR24-DW03; SEDAR24-DW04; and SEDAR25-DW05. SEDAR24-DW03 was a data working paper describing the computation of a fishery dependent index from the recreational headboat data. This working paper was helpful for determining if the index should be recommended for use and no revisions were required. SEDAR24-DW04 was a data working paper describing the computation of a fishery dependent index from the commercial logbook data. This working paper was helpful for determining if the index should be recommended for use and no revisions were required. SEDAR24-DW05 was a data working paper describing the computation of a fishery dependent index from the recreational MRFSS/MRIP data for the charter and private modes combined. This working paper was a helpful starting point for determining if the index should be recommended for use. The group discussion, documented below, led to this index not be recommended for use and thus, no revisions were required.

## 5.3 Fishery Independent Indices

Index report cards for all fishery independent data considered at the data workshop can be found in Appendix 5. All fishery independent surveys considered were MARMAP (Marine Resources Monitoring Assessment and Prediction) surveys. Red snapper have been sampled in low numbers by the MARMAP program with a variety of gear types (Table 5.3.1), although mainly with the Chevron trap and Yankee trawl. Although these gear types and sampling methodologies are not specifically designed to sample red snapper populations, the DW considered the data as a possible source to develop an index of abundance.

## 5.3.1 MARMAP Chevron trap

### 5.3.1.1 Methods, Gears, and Coverage

Chevron traps were baited with cut clupeids and deployed at stations randomly selected by computer from a database of approximately 2,500 live bottom and shelf edge locations and buoyed ("soaked") for approximately 90 minutes. During the 1990s, additional sites were selected, based on scientific and commercial fisheries sources, off North Carolina and south Florida to facilitate expanding the overall sampling coverage. Spatial coverage included areas from Florida through North Carolina.

### 5.3.1.2 Sampling intensity and time series

Chevron traps were deployed from 1990 through 2008. The CPUE from MARMAP chevron trap data was computed in units of number of fish caught per trap. In spite of relatively extensive regional coverage (Figure 5.3.1.1), there were few traps that captured red snapper (1-18 per year; Table 5.3.1.1) and few fish caught (4-44 red snapper caught per year).

### 5.3.1.3 Size/Age data

Not applicable

### 5.3.1.4 Catch Rates – Number and Biomass

The average nominal CPUE was 0.035 fish/trap-hr (range 0.007 – 0.066).

### 5.3.1.5 Uncertainty and Measures of Precision

Not applicable

### 5.3.1.6 Comments on Adequacy for assessment

Among the concerns with the index from chevron traps was that spatial variability in abundance and sampling locations would mask any temporal trends. Because of the low catches and the high variability in the data, the DW did not recommend using MARMAP chevron trap samples to develop an index of abundance for red snapper off the southeastern U.S.

## 5.3.2 MARMAP hook and line gears

### 5.3.2.1 Methods, Gears, and Coverage

Hook and line gears included Electramate rods or manual rods. There was much variation in fishing times, number of anglers, configuration of terminal tackle and bait (live and artificial) used. Hook and line collections were any haphazardly deployed angling gear used by either the scientific party or boat crew.

### 5.3.2.2 Sampling intensity and time series

Hook and line gears were deployed from 1983 through 2009. Due to the variation in fishing methodology, CPUE was not calculated for this gear.

### 5.3.2.3 Size/Age data

Not applicable

#### 5.3.2.4 Catch Rates – Number and Biomass

Not applicable

#### 5.3.2.5 Uncertainty and Measures of Precision

Not applicable

#### 5.3.2.6 Comments on Adequacy for assessment

Personnel and level of effort have changed over time, compromising the utility of the hook and line survey as an index. Much of the hook and line effort was conducted over mid-shelf depths, and as such may not provide an adequate representation of the complete range of red snapper. As a result, the DW did not recommend using the MARMAP hook and line samples to develop an index of abundance.

### 5.3.3 MARMAP Short longlines

#### 5.3.3.1 Methods, Gears, and Coverage

The short bottom long line was deployed to catch grouper/snapper over high relief and rough bottom types at depths of 90 to 200 m. This bottom line consisted of 25.6 m of 6.4 mm solid braid dacron groundline dipped in green copper naphenate. The line was deployed by stretching the groundline along the vessel's gunwale with 11 kg weights attached at the ends of the line. Twenty gangions baited with whole squid were placed 1.2 m apart on the groundline which was then attached to an appropriate length of poly warp and buoyed to the surface with a Hi-Flyer. Sets were made for 90 minutes and the gear was retrieved using a pot hauler.

#### 5.3.3.2 Sampling intensity and time series

Short longlines were deployed from 1996 through 2009, and during that time only captured 1 red snapper.

#### 5.3.3.3 Size/Age data

Not applicable

#### 5.3.3.4 Catch Rates – Number and Biomass

Not applicable

#### 5.3.3.5 Uncertainty and Measures of Precision

Not applicable

#### 5.3.3.6 Comments on Adequacy for assessment

Because of the extremely low catches, the DW did not recommend using the MARMAP short bottom long line samples to develop an index of abundance for red snapper.

### 5.3.4 MARMAP Yankee Trawl

#### 5.3.4.1 Methods, Gears, and Coverage

Yankee trawls were towed for 30 minutes at 6.5 km/h (3.5 knots). This gear was primarily used on regional sand-bottom surveys of the continental shelf and upper slope. The sweep of the Yankee Trawl was 8.748 m, and 3.241 km was the distance covered during a standard 30-min tow (Wenner et al. 1979a), resulting in a swept area of 2.835 ha/tow.

#### 5.3.4.2 Sampling intensity and time series

Yankee trawls were used from 1973 to 1979. In spite of relatively extensive regional coverage, there were few Yankee trawls that captured red snapper (3-10 per year) and low sample sizes per year (3-37 per year).

#### 5.3.4.3 Size/Age data

Not applicable

#### 5.3.4.4 Catch Rates – Number and Biomass

Not applicable

#### 5.3.4.5 Uncertainty and Measures of Precision

Not applicable

#### 5.3.4.6 Comments on Adequacy for assessment

Because of the low catches, high variability, and short time series, the DW did not recommend using the MARMAP Yankee trawl samples to develop an index of abundance for red snapper.

### 5.3.5 MARMAP Blackfish traps

#### 5.3.5.1 Methods, Gears, and Coverage

Blackfish traps were baited with cut herrings (Brevoortia or Alosa spp., family Clupeidae), placed in the bait wells. Traps were deployed on buoyed lines (2 to a buoy or individually) usually separated by 30.5-m line, or tied off to an anchored vessel (1988 – 1989). Traps were generally set on live-bottom reef areas at depths < 50 m. Each trap soaked for approximately 90 minutes and was retrieved using a hydraulic pot hauler.

#### 5.3.5.2 Sampling intensity and time series

Blackfish traps were used from 1977 to 1989, and in 2006, 2007 and 2008 (for a trap comparison study). Only 7 red snapper was collected with the MARMAP blackfish trap.

#### 5.3.5.3 Size/Age data

Not applicable

#### 5.3.5.4 Catch Rates – Number and Biomass

Not applicable

#### 5.3.5.5 Uncertainty and Measures of Precision

Not applicable

#### 5.3.5.6 Comments on Adequacy for assessment

Because of the low catches and high variability, the DW did not recommend using the MARMAP blackfish trap samples to develop an index of abundance for red snapper.

### 5.3.6 MARMAP Florida Antillean traps

#### 5.3.6.1 Methods, Gears, and Coverage

Florida Antillean traps were baited with cut herrings (Brevoortia or Alosa spp., family Clupeidae) placed in the bait wells. Traps were deployed individually with 8-mm (5/16-inch) polypropylene line attached to a Hi-Flyer buoy or tied off an anchored vessel (1988-1989). Traps were generally set on live-bottom reef areas on the continental shelf and upper slope. Each trap soaked between 90 and 120 minutes and retrieved with a hydraulic pot hauler.

#### 5.3.6.2 Sampling intensity and time series

Florida Antillean Traps were used from 1980 through 1989, and in 2006, 2007 and 2008 (for a trap comparison study). Only 14 red snapper was collected with the MARMAP Florida Antillean trap.

#### 5.3.6.3 Size/Age data

Not applicable

#### 5.3.6.4 Catch Rates – Number and Biomass

Not applicable

#### 5.3.6.5 Uncertainty and Measures of Precision

Not applicable

#### 5.3.6.6 Comments on Adequacy for assessment

Because of the low catches and high variability, the DW did not recommend using the MARMAP Florida Antillean trap samples to develop an index of abundance for red snapper.

## 5.4 Fishery Dependent Indices

Index report cards for all fishery dependent data considered at the data workshop can be found in Appendix 5.

### 5.4.1 Recreational Headboat

The headboat fishery in the south Atlantic includes for-hire vessels that typically accommodate 11-70 passengers and charge a fee per angler. The fishery uses hook and line gear, generally targets hard bottom reefs as the fishing grounds, and generally targets species in the snapper-grouper complex. This fishery is sampled separately from other fisheries, and the available data were used to generate a fishery dependent index, with the size and age range of fish the same as that of landings from the headboat fishery.

Headboats in the south Atlantic are sampled from North Carolina to the Florida Keys (Figure 5.4.1.1). Data have been collected since 1972, but logbook reporting did not start until 1973. In addition, only North Carolina and South Carolina were included in the earlier years of the data set. In 1976, data were collected from North Carolina, South Carolina, Georgia, and northern Florida, and starting in 1978, data were collected from southern Florida (areas 11, 12, and 17).

Variables reported in the data set include year, month, day, area, location, trip type, number of anglers, species, catch, and vessel id. Biological data and discard data were recorded for some trips in some years.

The development of the CPUE index is described in more detail in SEDAR24-DW03. The size and age range of fish included in the index is the same as that of landings from this same fleet. The time series used for construction of the index spanned 1976–2009 because the area with the highest red snapper catches was covered during this entire time series.

### 5.4.1.1 Methods of Estimation

*Subsetting trips*

Trips to be included in the computation of the index need to be determined based on effort directed at red snapper. Effort can be determined directly for trips which had positive red snapper catches, but some trips likely directed effort at red snapper, but were unsuccessful at landing red snapper. Given that information on directed effort for trips without red snapper harvest is not available, another method must be used to compute total effort.

In order to determine effort that was likely directed at red snapper and which trips should be used to compute an index, the method of Stephens and MacCall (2004) was applied. The Stephens and MacCall method uses multiple logistic regression to estimate a probability for each trip that the focal species was caught, given other species caught on that trip. Species compositions differ across the south Atlantic; thus, the method was applied separately for two different regions: north (areas 2-10) and south (areas 11, 12, and 17; Shertzer and Williams 2009). To avoid computation errors, the number of species in each analysis was limited to those species that occurred in 1% or more of trips. The most general model therefore included all species in the snapper-grouper complex which occurred in 1% or more of trips as main effects, excluding red porgy. Red porgy was eliminated because of regulation changes, which could erroneously remove trips likely to have caught red snapper in recent years. A backwards stepwise AIC procedure (Venables and Ripley 1997) was then used to perform further selection among possible species as predictor variables. In this procedure, a generalized linear model with Bernoulli response was used to relate presence/absence of red snapper in headboat trips to presence/absence of other species. A trip was included as effort if the trip's probability of catching red snapper was higher than a threshold probability.

*Standardization method*

Catch per unit effort (CPUE) has units of fish/angler-hour and was calculated as the number of red snapper landed divided by the product of the number of anglers and the number of trip hours. CPUE was modeled using the delta-glm approach (cf., Lo et al. 1992; Dick 2004; Maunder and Punt 2004). Factors included in the glm included year, area, season, trip type, and number of anglers as a categorical variable. The effort by factor and landings by factor are shown in Table 5.4.1.3, as well as the proportion of positive effort by factor. In particular, fits of lognormal and gamma models were compared for positive CPUE, and the predictor variables described above were examined to determine which best explained CPUE patterns (both for positive CPUE and 0/1 CPUE). Jackknife estimates of variance were computed using the 'leave one out' estimator (Dick 2004).

The Bernoulli sub-model was fit with all main effects in order to determine which should remain in the binomial component of the delta-GLM. Stepwise AIC (Venables and Ripley1997) with a backwards selection algorithm was then used to eliminate those that did not improve model fit. In this case, the stepwise AIC procedure did not remove any predictor variables.

The positive portion of the model was fit with all main effects using both the lognormal and gamma distributions. Stepwise AIC (Venables and Ripley1997) with a backwards selection algorithm was then used to eliminate those that did not improve model fit. Backwards model selection eliminated only the trip type variable for the lognormal distribution and did not eliminate any of the predictor variables for the gamma distribution.

The lognormal model with all factors except trip type was used for computing the positive component of the index, and the binomial with all factors was used for computing the Bernoulli component of the index.

#### 5.4.1.2 Sampling Intensity

The resulting data set, after applying the Stephens and MacCall method, contained 46,404 trips in the northern region and 29,548 (64%) of those trips were positive, and 1,662 trips in the southern region and 413 (25%) of those trips were positive. A summary of the total number of trips with red snapper effort per year is provided in Table 5.4.1.1, and a summary of the total number of trips with positive red snapper catch per year is provided in Table 5.4.1.2.

#### 5.4.1.3 Size/Age data

The sizes/ages represented in this index should be the same as those of landings from the corresponding fleet (See section 4 of this report).

#### 5.4.1.4 Catch Rates

Nominal and standardized catch rates are shown in Figure 5.4.1.2 and are tabulated in Table 5.4.1.4.

#### 5.4.1.5 Uncertainty and Measures of Precision

Measures of precision were computed using a jackknife procedure. Annual CVs of catch rates are tabulated in Table 5.4.1.4.

#### 5.4.1.6 Comments on Adequacy for Assessment

The index of abundance from the headboat data was considered by the indices working group to be adequate for use in this assessment. The data cover the full range of the stock for the South Atlantic and is a complete census of the headboats. The data set has an adequately large sample size and has a long enough time series to provide potentially meaningful information for the assessment. The sampling was consistent over time, and some of the data were verified by port samplers and observers. These data represent effort for snapper-grouper species and not necessarily for the focal species, which should minimize changes in catchability relative to fishery dependent indices that target specific species. The primary caveat about this index is that it was derived from fishery dependent data.

#### 5.4.1.7 Decision to have headboat index represent both headboat and MRFSS charterboats

The recreational fishery working group made a recommendation that the recreational fishery be split into private boat and for-hire (charterboat and headboat) fisheries, which was accepted by the data workshop panel. There were two potential indices that could be used to represent the for-hire fishery: the recreational headboat index and an index constructed from MRFSS charterboat data. A MRFSS charterboat index was not constructed, because the indices working group felt that the recreational headboat index would better represent the for-hire recreational fishery. If a MRFSS charterboat index were constructed, and it agreed with the headboat index, then likely only the headboat index would be recommended for use in the assessment. Likewise, if the MRFSS charterboat index did not agree with the headboat index, then only the headboat index would be recommended for use in the assessment. In both cases, the headboat index would be recommended over the MRFSS charterboat index, because MRFSS charterboat data have much smaller sample sizes, higher uncertainty, and a shorter time series than the headboat data (a MRFSS index would begin in 1991, when data could be identified to the level of trip). MRFSS discards are self-reported and less reliable than the headboat data. In addition, the headboat fishery targets the entire snapper-grouper complex rather than specifically targeting red snapper, which should minimize changes in catchability over time. The data workshop panel accepted this recommendation from the indices working group.

### 5.4.2 Index of Abundance from commercial logbook data

Landings and fishing effort of commercial vessels operating in the southeast U.S. Atlantic have been monitored by the NMFS Southeast Fisheries Science Center through the Coastal Fisheries Logbook Program (CFLP). The program collects information about each fishing trip from all vessels holding federal permits to fish in waters managed by the Gulf of Mexico and South Atlantic Fishery Management Councils. Initiated in the Gulf in 1990, the CFLP began collecting logbooks from Atlantic commercial fishers in 1992, when 20% of Florida vessels were targeted. Beginning in 1993, sampling in Florida was increased to require reports from all vessels permitted in coastal fisheries, and since then has maintained the objective of a complete census of federally permitted vessels in the southeast U.S.

As described in SEDAR24-DW04, catch per unit effort (CPUE) from the logbooks was used to develop an index of abundance for red snapper landed with vertical lines (manual handline and electric reel), the dominant gear for this red snapper stock. Thus, the size and age range of fish included in the index is the same as that of landings from this same fleet. The time series used for construction of the index spanned 1993–2009, when all vessels with federal snapper-grouper permits were required to submit logbooks describing each fishing trip.

#### 5.4.2.1 Methods of Estimation

*Available data and treatment*

For each fishing trip, the CFLP database included a unique trip identifier, the landing date, fishing gear deployed, areas fished, number of days at sea, number of crew, gear-specific fishing effort, species caught, and weight of the landings. Fishing effort data available for vertical line gear included number of lines fished, hours fished, and number of hooks per line. For this southeast U.S. Atlantic stock, areas used in analysis were those between 24 and 36 degrees latitude, inclusive of the boundaries (Figure 5.4.2.1).

Effective effort was based on those trips from areas where red snapper were available to be caught. Without fine-scale geographic information on fishing location, trips to be included in the analysis must be inferred, which was done here using the method of Stephens and MacCall (2004). The method uses multiple logistic regression to estimate a probability for each trip that the focal species was caught, given other species caught on that trip. Because a zoogeographic boundary is apparent near Cape Canaveral (Shertzer et al., 2009), the method was applied separately to data from regions north and south of 28 degrees latitude (near Cape Canaveral). A backward stepwise AIC procedure (Venables and Ripley, 1997) was then used to perform further selection among possible species as predictor variables, where the most general model included all listed species as main effects. In this procedure, a generalized linear model with Bernoulli response was used to relate presence/absence of red snapper in each trip to presence/absence of other species. A trip was then included if its associated probability of catching red snapper was higher than a threshold probability.

*Standardization methods*

CPUE was modeled using the delta-GLM approach (Lo et al., 1992; Dick, 2004; Maunder and Punt, 2004). This approach combines two separate generalized linear models (GLMs), one to describe presence/absence of the focal species, and one to describe catch rates of successful trips (trips that caught the focal species). The response variable, CPUE, was calculated for each trip as,

CPUE = pounds of red snapper landed/hook-hours

where hook-hours is the product of number of lines fished, number of hooks per line, and total hours fished. Explanatory variables, all categorical, are described below. Estimates of variance were based on the jackknife “leave one out” estimator. All analyses were programmed in R, with much of the code adapted from Dick (2004).

A Bernoulli sub-model was used to describe the presence/absence of red snapper caught on each trip. Lognormal and gamma sub-models were considered to explain the distribution of catch rates on trips successful for red snapper, and the lognormal model was selected based on AIC.

Explanatory variables (levels) considered were year (1993─2009), season (spring, summer, fall, winter), area (NC, SC, GA, North FL, South FL), days at sea (1, 2─4, 5+), and crew size (1, 2, 3+). Applied separately to the Bernoulli and lognormal sub-models, backward stepwise AIC was used to select explanatory variables. In each case, all explanatory variables were retained. Total effort and landings by factor are shown in Table 5.4.2.1.

#### 5.4.2.2 Sampling Intensity

After applying the Stephens and MacCall method, the resulting subsetted data set contained 17,692 trips in the northern sampling areas (NC–North FL), of which ~63% were positive, and 2,603 trips from the southern sampling area (South FL), of which ~35% were positive. Annual number of trips on which the index is based are shown in Table 5.4.2.2, as well as annual proportion positive.

#### 5.4.2.3 Size/Age data

The sizes/ages represented in this index should be the same as those of landings from the corresponding fleet (commercial vertical lines, i.e., handlines).

#### 5.4.2.4 Catch Rates

Nominal and standardized catch rates are shown in Figure 5.4.2.2 and are tabulated in Table 5.4.2.2.

#### 5.4.2.5 Uncertainty and Measures of Precision

As described previously, measures of precision were computed using a jackknife procedure. Annual CVs of catch rates are tabulated in Table 5.4.2.2.

#### 5.4.2.5 Comments on Adequacy for Assessment

The index of abundance from commercial logbook data was considered by the indices working group to be adequate for use in assessment. The data cover the full range of the stock and, because the logbooks are intended to be a complete census of commercial fishermen with snapper-grouper permits, have an adequately large sample size. In addition, the time series has a long enough duration (17 years) to provide potentially meaningful information for the assessment. The primary caveat about this index is that it was derived from fishery dependent data.

### 5.4.3 MRFSS/MRIP Recreational Intercepts
(Private mode only - See section 5.4.1.7 for charter boat mode discussion.)

The Marine Recreational Fisheries Statistics Survey (MRFSS) samples the general recreational fishery. This national survey intercepts anglers fishing from shore, man-made structures, private/rental boats, and charter boats. Headboats are another component of recreational fishing, but they are sampled by a separate headboat survey. Based on the recommendations of the recreational workgroup (see section 4: headboats and charter boats were combined into a for-hire sector and private boats were left as a separate sector) only private boats were included in calculating the landings and thus were considered for this index. Because red snapper in the South Atlantic are considered distinct from those in the Gulf of Mexico, only MRFSS intercepts from North Carolina through Miami-Dade county in Florida were included in this analysis (Figure 5.4.3.1). Although MRFSS intercepts began in 1979, MRFSS changed their sampling protocol in 1991 to link additional interviews from the same trip together. Additionally, 1991 was the first full year after the extensive training of samplers had been implemented. Therefore, the index of abundance discussed only used data from 1991 through 2009 for the private boat mode only. However, the indices workgroup thought that, if a MRFSS private boat index were used, it should begin in 1999, because before 1999, the samples sizes were low.

#### 5.4.3.1 Methods of Estimation

There were 112,123 MRFSS intercepts in the private boat mode from nearshore (state) and offshore waters (federal), and 73 species including red snapper occurred on at least 0.25% of those intercepts. In this analysis, those additional intercepts from the same fishing trip that caught fish but were unavailable to the creel sampler were linked back to the main intercept for the party.

Over the 19 years from 1991 through 2009, there were 846 trips that caught red snapper in the study area. Including trips with discards did not greatly increase sample size. However, there were trips that could have caught red snapper, but didn't. To identify that effort and include it in the catch rate standardization process, Stephens and MacCall (2004) logistic regressions (S&M) were employed. The rationale of S&M is to identify a homogeneous group of intercepts that are believed to reflect the abundance of the target species. The S&M method uses a logistic regression of presence or absence by species on each intercept to predict whether the target species (red snapper) could be caught on the trip. Following Stephens and MacCall's example, species that occurred on less than 1% of the total number of intercepts were omitted.

For the S&M method, the intercept data were rearranged to one record per intercept with binomial (presence or absence) information for each of the 73 species. The response variable in the logistic regression was the presence (1) or absence (0) of red snapper on each intercept and the predictor variables in the full model were the presence or absence of the other 72 species. There were 27 species (Figure 5.4.3.2) whose regression coefficients were significant at the $\alpha = 0.05$ level and those species were used in the final, reduced model.

Potential thresholds (estimated probability of catching red snapper) for choosing whether to include an intercept in the catch rate analysis ranged from 0.01 to 0.99 and the critical value was based on the minimum absolute difference between observed number of intercepts with red snapper and the predicted number of intercepts. The smallest absolute difference occurred with a threshold of 0.160. There were 850 intercepts that exceeded the 0.160 threshold.

Standardization was not performed because it was determined at this point that sample size issues would make the index inadequate for use in the model.

#### 5.4.3.2 Sampling Intensity

Sampling intensity (number of intercepted trips) in the study area by year is shown in Table 5.4.3.1.

#### 5.4.4.3 Size/Age Data

Sizes and ages of fish represented by this index are the same as those of the recreational fishery as sampled by the MRFSS (see Chapter 4 of this DW report).

#### 5.4.3.4 Catch Rates – Number and Biomass

Table 5.4.3.1 and Figure 5.4.3.3 show the nominal red snapper catch rate (number/trip).

#### 5.4.3.5 Uncertainty and Measures of Precision

Table 5.4.3.1 and Figure 5.4.3.3 show the coefficient of variation for the nominal red snapper catch rate.

#### 5.4.3.6 Comments on Adequacy for Assessment

MRFSS private boat mode only intercepts anglers at public landings, missing anglers that launch from private landings. Therefore, MRFSS may not represent the entire private boat fishery. Given the relatively low sample size and high variability for a fishery dependent index and the suspected lack of representation of the fishery, the indices work group does not feel that this index is adequate for the assessment and does not recommend it for inclusion in the model. This recommendation was accepted at the plenary session.

### 5.4.4 Recreational SC V1 Vessel Logbook Data

In 1993, SCDNR's Marine Resources Division (MRD) initiated a mandatory logbook reporting system for all charter vessels to collect basic catch and effort data. Under state law, vessel owners/operators carrying fishermen on a for-hire basis are required to submit monthly trip level reports of their fishing activity in waters off of SC. The charter boat logbook program is a complete census and should theoretically represent the total catch and effort of the charter boat trips in waters off of SC. The charter logbook reports include: date, number of fishermen, fishing locale (inshore, 0-3 miles, >3miles), fishing location (based on a 10x10 mile grid map), fishing method, hours fished, target species, and catch (number of landed and released fish by species) per vessel per trip. The logbook forms have remained similar throughout the program's existence with a few exceptions: in 1999 the logbooks forms were altered to begin collecting the number of fish released alive and the number of fish released dead (prior to 1999 only the total number of fish released were recorded) and in 2008 additional fishing methods were added to the logbook forms, including cast, cast and bottom, and gig.

#### 5.4.4.1 Methods of Estimation

A subset of the data was created using the Stephens and MacCall (2004) method. To be included, the species had to be present in a minimum of 1% of the trips. Species were then selected by backward stepwise AIC. The subsetting method effectively removed all inshore trips. Data was standardized with delta-GLM standardization method. The predictors included were year, season, number of anglers, and method of fishing. Variance was estimated using a jackknife procedure.

#### 5.4.4.2 Sampling Intensity

SCDNR logbook vessel trips represent snapper grouper fishing trips where at least one of a suite of bottom fishes (likely, or even possibly, to occur in association with red snapper) were caught. Trips that were a combination of trolling and bottom fishing were included. These raw logbook data represent 15,260 fishing trips in which 65,215 anglers caught 10,114 red snapper and harvested 4,368 red snapper before the Stephens and MacCall selection procedure (Table 5.4.4.1).

#### 5.4.4.3 Size/Age data

Not applicable.

#### 5.4.4.4 Catch Rates – Number and Biomass

Catch per unit effort was calculated as the number of fish kept per angler-hour. Table 5.4.4.2 and Figure 5.4.4.1 show the nominal and standardized red snapper catch rates.

#### 5.4.4.5 Uncertainty and Measures of Precision

Table 5.4.4.2 and Figure 5.4.4.1 show the coefficients of variation.

#### 5.4.4.6 Comments on Adequacy for Assessment

Because the data only cover one area and are already reported in other datasets, the DW did not recommend using SC Charter logbook data to develop an index of abundance for red snapper off the southeastern U.S. The DW did note that it followed similar trends seen in the other indices, particularly the nominal index for South Carolina headboats.

### 5.4.5 Other Data Sources Considered

Several fishery-dependent datasets were introduced at the SEDAR 24 data workshop and considered by the Indices Workgroup. South Atlantic landings data from commercial logbooks from 1975-1990 were presented, but no fishing effort was available to compute a CPUE index.

Captain Steve Amick also presented records of his headboat fishing catch and effort in Georgia from 1983-2009. The overall pattern of this index appeared consistent with the more comprehensive headboat logbook records, which contained the latter portion (1994-2009) of the index. Additionally, the Indices Workgroup was concerned with the limited geographic coverage and the limited sample size (containing only records from one fisherman). Thus, the indices work group did not recommend these data for inclusion as an index, and this recommendation was accepted by the data workshop panel.

#### 5.4.5.1 Headboat at-sea observer data

At-sea observer sampling of anglers in the headboat fishery was conducted from 2005-2009 in Florida and Georgia, and from 2004-2009 in North and South Carolina. These data are more fully described in SEDAR24-DW15. The dataset available at the workshop was the data from Florida, and a nominal CPUE index of discards was computed from the Florida data. Because the observers recorded the number and lengths of all fish caught, this index provides valuable information on both the amount and size composition of the discarded catch. This index could provide information on the relative strengths of young age classes observed by the fishery, and thus could provide the assessment with recruitment signals in recent years. However, this index was not standardized prior to the DW, and there is limited time and resources to do so in time for the assessment workshop. Options include (in order of increasing work): 1) not include the index; 2) include the nominal CPUE index; 3) conduct a standardization of only the trips that caught red snapper; and 4) conduct a standardization of all trips that could be considered effort for red snapper, with effort identified with the Stephens and MacCall (2004) approach. The Indices Workgroup recommends that an attempt be made to standardize the index, but use the nominal CPUE if the standardization cannot be completed in time. Although this data set was available for review by the Indices Group, the standardized index itself was not, and thus the group further recommends that this index receive additional evaluation from the assessment panel.

## 5.5 Consensus Recommendations and Survey Evaluations

No fishery independent indices were recommended for use in the assessment, and three fishery dependent indices were recommended: recreational headboat index; commercial logbook index; and headboat at sea observer discards index. The two indices that have been computed are compared graphically in Figure 5.5.1. A summary of each index and their CVs are presented in Table 5.5.1. The correlation between the two indices was 0.767 (P-value=0.00; $H_A$: true correlation is not equal to 0).

The relative ranking of the reliability of the recommended indices was discussed. Based on these discussions, the indices recommended for the assessment were ranked as follows:

1. Headboat index
    - Longest time series
    - Operates in a manner more similar to fishery independent data collection because the fishery targets the snapper-grouper complex in general rather than the focal species specifically
2. Commercial logbook index
3. Headboat at sea observer discard index
    - Shortest time series
    - Lower representation from other states in south Atlantic compared to Florida (for example, 36 trips total in Georgia: SEDAR24-DW15).

Finally, as part of the data workshop, the work group discussed potential changes in red snapper catchability with approximately 6-9 fishermen who participated in the data workshop. We thank those fishermen for taking the time to discuss this topic, as fishermen have firsthand knowledge on potential changes in catchability over time. For more general changes in catchability for the south Atlantic, please see SEDAR 2009, and for a longer history of the red snapper fishery see SEDAR24-DW11. Based on this discussion of red snapper specific catchability changes from the 1970s to the present, below is a list of potential factors that could have changed catchability and when those changes occurred:

- 1970’s Loran C was introduced and increased catchability for those who were entering or newer in the fishery
- 2000 GPS was becoming prevalent and likely increased the catchability for casual and newer fishermen
- Gear has not changed much-in northern part of region (for the commercial fishery)
- Gear in the southern part of the region (FL; for the commercial fishery) has changed from bandits to rod and reels with the change occurring in 2004/2005.
- The recreational headboat gear has not changed much over time.
- The fishermen felt that the overall expertise of fishermen as a collective group was pretty constant over time as members left the fishery and as new members joined the fishery.

- Thermoclines (i.e. Labrador current upwelling) have become more frequent in last few years and occur during a larger part of the year in recent years. This has caused reduced catchability as fish do not want to bite and are more inactive.
- 2003/2004 were active hurricane years with 4-6 weeks of fishing time lost after hurricanes.
- Fuel prices since 2005 have increased and have reduced the number of trips. This should be accounted for in reported fishing effort.
- A red tide event in 2007 which ranged up to northern FL and GA
- 

## 5.6 Itemized List of Tasks for Completion following Workshop

- Draft of indices work group text to work group by end of day June 2
- Comments on text to work group leader by end of day on June 9
- Final text to SEDAR by June 11
- Attempt to compute the standardized headboat at sea observer discards index, Amy Schueller, deadline: June 18, 2010

## 5.7 Literature Cited

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## 5.8 Tables

**Table 5.1.1.** Table of the data considered for the construction of a CPUE index.

| Fishery Type | Data Source | Area | Years | Units | Standardization Method | Issues | Use? |
|---|---|---|---|---|---|---|---|
| Independent | MARMAP Chevron Trap | NC – FL | 1990-2009 | Fish / trap hour | - | Low catch<br>High variance | No |
| Independent | MARMAP Yankee Trawl | NC-FL | 1973-1979 | Number / trawl | - | Low catch<br>High variance | No |
| Independent | MARMAP Blackfish | NC-FL | 1978-1988 | Number / trap hour | - | Low catch | No |
| Independent | MARMAP FL Antillian trap | NC-FL | 1981-1987 | Number / trap hour | - | Low catch | No |
| Independent | MARMAP Short longline | NC-FL | 1980-2009 | Number / hook hour | - | 1 red snapper caught | No |
| Independent | MARMAP Hook and line | NC-FL | 1983-2009 | Number / hook hour | - | Change in methodology over time<br>Designed to supplement age-growth datasets | No |
| Recreational | Headboat | NC-FL | 1976-2009 | Fish/ angler-hour | Delta glm | Fishery dependent | ***Yes*** |
| Recreational | MRFSS: private boat | NC-FL | 1991-2009<br>1999-2009 | Fish/angler-trip<br>Fish/angler-trip | -<br>- | Low sample; high variability<br>Low sample size, high variability, whether or not representative of private boats | No |
| Commercial | SC Charter Boat | SC | 1993-2009 | Number fish kept/angler hrs | Delta glm | Only one state represented<br>Captured in other dataset | No |
| Commercial | Commercial Logbook | NC-FL | 1993-2009 | Lbs kept/hook hours | Delta glm | Fishery dependent | ***Yes*** |
| Recreational | Steve Amick Headboat logbook data | GA | 1983-2009 | Fish /angler-trip | - | One fisherman only<br>Contained within headboat database in recent years<br>Limited geographic coverage (GA) | No |
| Commercial | Logbook landings | NC-FL | 1975-1990 | No CPUE index | - | No CPUE index because no effort data available | No |
| Recreational | Headboat at sea Observer Discard Data | NC-FL | 2005-2009 | Fish/ angler-hour | Delta glm | Using discards, fishery dependent | ***Yes*** |

**Table 5.2.1.** Table of the pros and cons for each data set considered at the data workshop.

<u>Fishery dependent indices</u>

Commercial Logbook – Handline (*Recommended for use*)

Pros:
- Complete census
- Covers entire management area
- Continuous, 17-year time series
- Large sample size

Cons:
- Fishery dependent
- Data are self-reported and largely unverified
- Little information on discard rates
- Catchability may vary over time or with abundance

Issues Discussed:
- Possible shift in fisherman preference may have been addressed by Stephens and MacCall (2004) approach
- In some cases, self-reported landings have been compared to TIP data, and they appear reliable
- Changes in catchability over time (e.g., due to advances in technology or knowledge) might be addressed in the assessment model

Recreational Headboat (*Recommended for use*)

Pros:
- Complete census
- Covers entire management area
- Longest time series available
- Some data are verified by port samplers and observers
- Consistent sampling
- Large sample size
- Non-targeted for focal species, which should minimize changes in catchability relative to fishery dependent indices that target specific species

Cons:
- Fishery dependent
- Little information on discard rates
- Catchability may vary over time or with abundance

- **Table 5.2.1 continued**

  Issues Addressed:
  - Possible shift in fisherman preference may have been addressed by Stephens and MacCall (2004) approach
  - Changes in catchability over time (e.g., due to advances in technology or knowledge) might be addressed in the assessment model

MRFSS-private mode (*Not recommended for use*)

Pros:
- Only data available on private boats

Cons:
- Fishery dependent
- Low sample sizes, particularly for a fishery dependent data set
- High uncertainty in MRFSS data
- Data may not be representative of private boat mode

SC logbook data for V1 vessels *(Not recommended for use)*

Pros:
- Census of charter vessels with 1-6 passengers in SC
- Continuous, 17-year time series
- Relatively large sample size

Cons:
- Fishery dependent
- Data are self-reported and largely unverified
- Only one state, doesn't cover entire management area
- Included in other data sets potentially
- Catchability may vary over time or with abundance

1975-1990 commercial logbook landings *(Not recommended for use)*

Cons:
- No effort data available, thus no CPUE index could be computed

S. Amick Headboat logbook data 1983-2009 *(Not recommended for use)*

Cons:
- Included in the headboat database in more recent years (1994-2009)
- Limited geographic coverage (Georgia)
- Limited sample size (only trips from one fisherman)

Issues discussed:
- The HPUE trends are similar to the trends in the HB index

**Table 5.2.1 continued**

Florida headboat observer data

Pros:

- Observer program
- Good discard data (provides amount of discards and length frequency)
- Random sampling design
- Matches well with headboat logbooks
- More reliable depth recordings

Cons:

- Good coverage in Florida, but not as good in other states
- Short time series

Issues Discussed:

- Limited amount of time to compute a standardized index

<u>Fishery independent indices</u>

MARMAP

Chevron Trap Index (*Not recommended for use*)

Pros:

- Fishery independent random hard bottom survey
- Adequate regional coverage
- Standardized sampling techniques

Cons:

- Low sample sizes. Only 4-44 fish caught per year. Only 1-18 traps caught red snapper per year.
- High standard errors

Hook and Line Index (*Not recommended for use*)

Pros:

- Fishery independent random hard bottom survey
- Adequate regional coverage

Cons:

- Was not designed to compute an index, it was designed to collect biological samples
- Low sample sizes with frequent zeros.
- Restricted depth coverage (midshelf sampled)
- High standard errors
- Methodology has changed over time (bait types, number of hooks which wasn't recorded, ability of samplers, etc…)
- Level of effort has decreased over time

**Table 5.2.1 continued**

Short Bottom Longline Index (*Not recommended for use*)

Pros:
- Fishery independent random hard bottom survey
- Adequate regional coverage
- Standardized sampling techniques

Cons:
- Extremely low sample size. Only 1 fish caught in 1 year.
- No standard error

Blackfish trap (*Not recommended for use*)

Pros:
- Fishery independent random hard bottom survey
- Adequate regional coverage
- Standardized sampling techniques

Cons:
- Extremely low sample sizes. Only 1-2 fish caught per year.
- Short time series (1981-1988)
- High standard errors

Florida Antillean trap (*Not recommended for use*)

Pros:
- Fishery independent random hard bottom survey
- Adequate regional coverage
- Standardized sampling techniques

Cons:
- Extremely low sample sizes. Only 1-8 fish caught per year.
- Short time series (1981-1988)
- High standard errors

Yankee trawl (*Not recommended for use*)

Pros:
- Fishery independent random hard bottom survey
- Adequate regional coverage
- Standardized sampling techniques

Cons:
- Low sample sizes. Only 3-37 fish caught per year.
- Short time series (1973-1979)
- High standard errors

**Table 5.3.1.** MARMAP gear list. The total number of red snapper caught for each gear and year.

| Year | All gears | Blackfish trap, baited | Chevron trap | Fl Antillean trap | Hook and Line | Short long line | Yankee trawl, MARMAP |
|---|---|---|---|---|---|---|---|
| 1973 | 37 | | | | | | 37 |
| 1974 | 36 | | | | | | 36 |
| 1975 | 17 | | | | | | 17 |
| 1976 | 5 | | | | | | 5 |
| 1977 | 5 | | | | | | 3 |
| 1978 | 18 | | | | | | 14 |
| 1979 | 10 | | | | | | 7 |
| 1981 | 13 | 1 | | 8 | | | |
| 1982 | 40 | | | 1 | | | |
| 1983 | 6 | 1 | | 1 | | | |
| 1984 | 3 | | | 1 | | | |
| 1985 | 3 | 2 | | 1 | | | |
| 1986 | 3 | 1 | | 1 | | | |
| 1987 | 5 | 1 | | | 2 | | |
| 1988 | 40 | 1 | 24 | 1 | | | |
| 1989 | 6 | | 4 | | | | |
| 1990 | 27 | | 24 | | 2 | | |
| 1991 | 17 | | 17 | | | | |
| 1992 | 26 | | 21 | | 5 | | |
| 1993 | 31 | | 31 | | | | |
| 1994 | 54 | | 45 | | 3 | | |
| 1995 | 13 | | 13 | | | | |
| 1996 | 10 | | 10 | | | | |
| 1997 | 27 | | 26 | | | | |
| 1998 | 27 | | 25 | | 2 | | |
| 1999 | 22 | | 22 | | | | |
| 2000 | 17 | | 17 | | | | |
| 2001 | 11 | | 9 | | | | |
| 2002 | 40 | | 40 | | | | |
| 2003 | 7 | | 7 | | | | |
| 2004 | 5 | | 5 | | | | |
| 2005 | 12 | | 12 | | | | |
| 2006 | 6 | | 6 | | | | |
| 2007 | 32 | | 31 | | | 1 | |
| 2008 | 31 | | 29 | | 2 | | |
| 2009 | 21 | | 11 | | 3 | | |

| Total | 589 | 7 | 429 | 14 | 19 | 1 | 119 |
|---|---|---|---|---|---|---|---|

**Table 5.3.1.1.** Chevron trap catches: By year, the total number of chevron traps set (Coll.), the number of traps that caught red snapper (Coll. W RS), the CPUE (number of fish per trap-hour), and the number of red snapper caught (fish).

| Year | Collections | Collections with red snapper | CPUE | Fish |
|---|---|---|---|---|
| 1990 | 318 | 7 | 0.046 | 23 |
| 1991 | 281 | 6 | 0.053 | 17 |
| 1992 | 302 | 9 | 0.043 | 21 |
| 1993 | 393 | 12 | 0.049 | 31 |
| 1994 | 408 | 18 | 0.066 | 44 |
| 1995 | 453 | 7 | 0.016 | 13 |
| 1996 | 441 | 5 | 0.007 | 5 |
| 1997 | 430 | 6 | 0.034 | 24 |
| 1998 | 483 | 8 | 0.029 | 25 |
| 1999 | 231 | 4 | 0.055 | 22 |
| 2000 | 279 | 7 | 0.030 | 14 |
| 2001 | 233 | 7 | 0.025 | 9 |
| 2002 | 205 | 9 | 0.066 | 21 |
| 2003 | 203 | 1 | 0.018 | 7 |
| 2004 | 265 | 3 | 0.009 | 4 |
| 2005 | 288 | 7 | 0.025 | 12 |
| 2006 | 287 | 4 | 0.011 | 5 |
| 2007 | 318 | 7 | 0.055 | 28 |
| 2008 | 296 | 7 | 0.039 | 19 |
| 2009 | 390 | 8 | 0.016 | 10 |

**Table 5.4.1.1**. The total number of headboat trips with red snapper effort per year for each region.

| Year | NC | SC | GA-NFL | SFL | Total |
|---|---|---|---|---|---|
| 1976 | 144 | 226 | 440 | - | 810 |
| 1977 | 62 | 177 | 576 | - | 815 |
| 1978 | 147 | 236 | 1041 | 4 | 1428 |
| 1979 | 162 | 77 | 967 | 33 | 1239 |
| 1980 | 115 | 177 | 989 | 57 | 1338 |
| 1981 | 106 | 50 | 821 | 75 | 1052 |
| 1982 | 191 | 217 | 858 | 65 | 1331 |
| 1983 | 175 | 207 | 1108 | 70 | 1560 |
| 1984 | 84 | 189 | 1057 | 93 | 1423 |
| 1985 | 79 | 247 | 1181 | 162 | 1669 |
| 1986 | 97 | 247 | 1484 | 190 | 2018 |
| 1987 | 116 | 310 | 1487 | 178 | 2091 |
| 1988 | 119 | 348 | 1466 | 97 | 2030 |
| 1989 | 49 | 192 | 1062 | 51 | 1354 |
| 1990 | 66 | 252 | 1075 | 24 | 1417 |
| 1991 | 142 | 284 | 982 | 12 | 1420 |
| 1992 | 244 | 227 | 1519 | 67 | 2057 |
| 1993 | 178 | 259 | 1388 | 59 | 1884 |
| 1994 | 182 | 224 | 1101 | 59 | 1566 |
| 1995 | 182 | 209 | 1042 | 25 | 1458 |
| 1996 | 173 | 198 | 697 | 20 | 1088 |
| 1997 | 120 | 113 | 527 | 13 | 773 |
| 1998 | 210 | 209 | 1125 | 6 | 1550 |
| 1999 | 164 | 206 | 1166 | 5 | 1541 |
| 2000 | 188 | 202 | 982 | 15 | 1387 |
| 2001 | 157 | 274 | 1051 | 14 | 1496 |
| 2002 | 167 | 274 | 952 | 11 | 1404 |
| 2003 | 123 | 154 | 779 | 17 | 1073 |
| 2004 | 197 | 269 | 898 | 20 | 1384 |
| 2005 | 90 | 182 | 902 | 25 | 1199 |
| 2006 | 98 | 213 | 854 | 30 | 1195 |
| 2007 | 69 | 271 | 988 | 39 | 1367 |
| 2008 | 97 | 170 | 941 | 50 | 1258 |
| 2009 | 105 | 124 | 1086 | 76 | 1391 |
| Total | 4598 | 7214 | 34592 | 1662 | 48066 |

**Table 5.4.1.2**. The total number of headboat trips with positive red snapper catch per year for each region.

| Year | NC | SC | GA-NFL | SFL | Total |
|---|---|---|---|---|---|
| 1976 | 37 | 116 | 417 | - | 570 |
| 1977 | 32 | 61 | 514 | - | 607 |
| 1978 | 68 | 96 | 888 | 1 | 1053 |
| 1979 | 79 | 31 | 778 | 3 | 891 |
| 1980 | 49 | 104 | 752 | 11 | 916 |
| 1981 | 68 | 26 | 738 | 29 | 861 |
| 1982 | 110 | 112 | 710 | 6 | 938 |
| 1983 | 90 | 107 | 947 | 8 | 1152 |
| 1984 | 37 | 124 | 851 | 21 | 1033 |
| 1985 | 39 | 163 | 1043 | 46 | 1291 |
| 1986 | 62 | 110 | 953 | 27 | 1152 |
| 1987 | 45 | 149 | 1012 | 25 | 1231 |
| 1988 | 63 | 192 | 885 | 16 | 1156 |
| 1989 | 21 | 127 | 823 | 4 | 975 |
| 1990 | 21 | 168 | 806 | 2 | 997 |
| 1991 | 49 | 137 | 670 | 0 | 856 |
| 1992 | 75 | 110 | 392 | 17 | 594 |
| 1993 | 80 | 208 | 411 | 16 | 715 |
| 1994 | 55 | 135 | 569 | 22 | 781 |
| 1995 | 56 | 103 | 601 | 6 | 766 |
| 1996 | 41 | 59 | 425 | 8 | 533 |
| 1997 | 24 | 31 | 319 | 3 | 377 |
| 1998 | 32 | 80 | 665 | 1 | 778 |
| 1999 | 61 | 137 | 690 | 0 | 888 |
| 2000 | 55 | 86 | 643 | 7 | 791 |
| 2001 | 103 | 170 | 720 | 3 | 996 |
| 2002 | 96 | 205 | 664 | 2 | 967 |
| 2003 | 46 | 112 | 534 | 0 | 692 |
| 2004 | 42 | 168 | 725 | 2 | 937 |
| 2005 | 8 | 83 | 753 | 6 | 850 |
| 2006 | 11 | 69 | 606 | 12 | 698 |
| 2007 | 2 | 86 | 722 | 31 | 841 |
| 2008 | 22 | 65 | 856 | 26 | 969 |
| 2009 | 33 | 34 | 990 | 52 | 1109 |
| Total | 1712 | 3764 | 24072 | 413 | 29961 |

**Table 5.4.1.3.** Distribution of total effort (angler-hours), proportion effort positive, and landings by factor in the recreational headboat data set used to construct the index of abundance (i.e., after applying the Stephens and MacCall method).

| Factor | Total angler hours | Proportion effort positive | Landings (number) |
|---|---|---|---|
| Year | | | |
| 1976 | 308008 | 0.722 | 12996 |
| 1977 | 288094 | 0.750 | 12419 |
| 1978 | 468120 | 0.738 | 20400 |
| 1979 | 428553 | 0.723 | 19117 |
| 1980 | 425192 | 0.708 | 11096 |
| 1981 | 363419 | 0.836 | 15965 |
| 1982 | 565967 | 0.695 | 9279 |
| 1983 | 605272 | 0.740 | 13948 |
| 1984 | 576131 | 0.729 | 14883 |
| 1985 | 616558 | 0.796 | 20460 |
| 1986 | 742626 | 0.579 | 7205 |
| 1987 | 814520 | 0.592 | 8832 |
| 1988 | 698509 | 0.599 | 9375 |
| 1989 | 460382 | 0.725 | 8763 |
| 1990 | 525113 | 0.751 | 8688 |
| 1991 | 527628 | 0.633 | 7139 |
| 1992 | 732217 | 0.303 | 1891 |
| 1993 | 641294 | 0.429 | 3304 |
| 1994 | 534995 | 0.526 | 3101 |
| 1995 | 479419 | 0.547 | 3097 |
| 1996 | 395288 | 0.478 | 1650 |
| 1997 | 260285 | 0.468 | 1133 |
| 1998 | 500820 | 0.500 | 2593 |
| 1999 | 505470 | 0.620 | 3322 |
| 2000 | 449937 | 0.577 | 3689 |
| 2001 | 495936 | 0.675 | 6665 |
| 2002 | 455406 | 0.712 | 7091 |
| 2003 | 375825 | 0.657 | 3618 |

**Table 5.4.1.3 continued**

| | | | |
|---|---|---|---|
| 2004 | 468961 | 0.689 | 6341 |
| 2005 | 394777 | 0.696 | 4573 |
| 2006 | 398933 | 0.575 | 3972 |
| 2007 | 446960 | 0.616 | 4125 |
| 2008 | 413071 | 0.756 | 12619 |
| 2009 | 449443 | 0.808 | 12451 |
| Season | | | |
| fall | 2322037 | 0.684 | 62484 |
| spring | 6521819 | 0.655 | 100310 |
| summer | 5396101 | 0.571 | 64856 |
| winter | 2573172 | 0.686 | 58150 |
| Area | | | |
| GF | 10870402 | 0.734 | 244860 |
| NC | 2059356 | 0.392 | 7920 |
| SC | 2936582 | 0.554 | 30266 |
| SF | 946789 | 0.312 | 2754 |
| Anglers | | | |
| large | 12360503 | 0.645 | 176161 |
| small | 4452626 | 0.613 | 109639 |
| Trip type | | | |
| full | 15702560 | 0.649 | 271307 |
| half | 1110569 | 0.462 | 14493 |

**Table 5.4.1.4.** The relative nominal CPUE, number of trips with positive effort, portion of trips with positive red snapper catches, standardized index, and CV for the headboat fishery in the south Atlantic.

| Year | Relative nominal CPUE | N | Proportion N positive | Standardized index | CV (index) |
|---|---|---|---|---|---|
| 1976 | 2.333825 | 810 | 0.703704 | 2.301045 | 0.068914 |
| 1977 | 2.384366 | 815 | 0.744785 | 2.241804 | 0.066364 |
| 1978 | 2.410424 | 1428 | 0.737395 | 2.113801 | 0.051756 |
| 1979 | 2.467378 | 1239 | 0.719128 | 2.118015 | 0.055641 |
| 1980 | 1.443451 | 1338 | 0.684604 | 1.418691 | 0.052292 |
| 1981 | 2.429863 | 1052 | 0.818441 | 2.87604 | 0.051011 |
| 1982 | 0.90684 | 1331 | 0.704733 | 1.139134 | 0.049624 |
| 1983 | 1.274623 | 1560 | 0.738462 | 1.528256 | 0.047318 |
| 1984 | 1.42886 | 1423 | 0.725931 | 1.308457 | 0.051759 |
| 1985 | 1.835491 | 1669 | 0.773517 | 1.991512 | 0.046176 |
| 1986 | 0.536642 | 2018 | 0.570862 | 0.474538 | 0.052209 |
| 1987 | 0.599761 | 2091 | 0.588714 | 0.559273 | 0.049132 |
| 1988 | 0.742369 | 2030 | 0.569458 | 0.539267 | 0.05508 |
| 1989 | 1.052822 | 1354 | 0.720089 | 0.912407 | 0.054955 |
| 1990 | 0.91514 | 1417 | 0.703599 | 0.836733 | 0.051824 |
| 1991 | 0.748394 | 1420 | 0.602817 | 0.654579 | 0.055796 |
| 1992 | 0.142847 | 2057 | 0.28877 | 0.078295 | 0.073775 |
| 1993 | 0.284973 | 1884 | 0.379512 | 0.150414 | 0.071758 |
| 1994 | 0.320607 | 1566 | 0.498723 | 0.259337 | 0.065835 |
| 1995 | 0.357311 | 1458 | 0.525377 | 0.277886 | 0.063292 |
| 1996 | 0.230882 | 1088 | 0.48989 | 0.253117 | 0.068558 |
| 1997 | 0.240769 | 773 | 0.48771 | 0.265594 | 0.08029 |
| 1998 | 0.286379 | 1550 | 0.501935 | 0.235547 | 0.059401 |
| 1999 | 0.363517 | 1541 | 0.576249 | 0.298236 | 0.058135 |
| 2000 | 0.4535 | 1387 | 0.570296 | 0.418363 | 0.060791 |
| 2001 | 0.743353 | 1496 | 0.665775 | 0.803709 | 0.059722 |
| 2002 | 0.86125 | 1404 | 0.688746 | 0.963951 | 0.059374 |
| 2003 | 0.53248 | 1073 | 0.644921 | 0.530603 | 0.065141 |
| 2004 | 0.747897 | 1384 | 0.677023 | 0.829492 | 0.05305 |
| 2005 | 0.640722 | 1199 | 0.708924 | 0.803434 | 0.055258 |
| 2006 | 0.550719 | 1195 | 0.5841 | 0.454168 | 0.062385 |
| 2007 | 0.510477 | 1367 | 0.615216 | 0.462045 | 0.055522 |
| 2008 | 1.689744 | 1258 | 0.77027 | 1.858984 | 0.049069 |
| 2009 | 1.532322 | 1391 | 0.797268 | 2.043275 | 0.045586 |

**Table 5.4.2.1.** Distribution of total effort (hook-hours), proportion effort positive, landings, and nominal CPUE by factor in the commercial logbook data set used to construct the index of abundance (i.e., after applying the Stephens and MacCall method).

| Factor | Effort (hook-hours) | Proportion effort positive | Landings (lb) | Nominal CPUE (lb/hook-hr) |
|---|---|---|---|---|
| **year** | | | | |
| 1993 | 287270 | 0.86 | 46145 | 0.16 |
| 1994 | 537264 | 0.83 | 74476 | 0.14 |
| 1995 | 563254 | 0.79 | 82824 | 0.15 |
| 1996 | 531406 | 0.70 | 47796 | 0.09 |
| 1997 | 572568 | 0.65 | 50289 | 0.09 |
| 1998 | 385714 | 0.61 | 35597 | 0.09 |
| 1999 | 307274 | 0.60 | 35930 | 0.12 |
| 2000 | 287046 | 0.63 | 40337 | 0.14 |
| 2001 | 395724 | 0.74 | 85942 | 0.22 |
| 2002 | 442453 | 0.79 | 87538 | 0.20 |
| 2003 | 373747 | 0.74 | 70294 | 0.19 |
| 2004 | 326351 | 0.77 | 79034 | 0.24 |
| 2005 | 306796 | 0.71 | 61529 | 0.20 |
| 2006 | 334822 | 0.57 | 33028 | 0.10 |
| 2007 | 376422 | 0.56 | 45452 | 0.12 |
| 2008 | 302664 | 0.65 | 108573 | 0.36 |
| 2009 | 298868 | 0.67 | 145816 | 0.49 |
| **season** | | | | |
| fall | 1513375 | 0.68 | 294852 | 0.19 |
| spring | 1954222 | 0.74 | 326846 | 0.17 |
| summer | 1904370 | 0.65 | 243126 | 0.13 |
| winter | 1257675 | 0.77 | 265775 | 0.21 |
| **area** | | | | |
| GA | 913864 | 0.89 | 169539 | 0.19 |
| NC | 748402 | 0.53 | 63005 | 0.08 |
| NF | 1824230 | 0.84 | 554221 | 0.30 |
| SC | 3016545 | 0.61 | 287494 | 0.10 |
| SF | 126602 | 0.61 | 56341 | 0.45 |
| **crew size** | | | | |
| one | 176308 | 0.64 | 53565 | 0.30 |
| threeplus | 4930509 | 0.73 | 763866 | 0.15 |
| two | 1522825 | 0.63 | 313169 | 0.21 |
| **days at sea** | | | | |
| fiveplus | 4581099 | 0.76 | 657847 | 0.14 |
| one | 140936 | 0.44 | 104201 | 0.74 |
| twotofour | 1907607 | 0.60 | 368552 | 0.19 |

**Table 5.4.2.2.** Standardized index of red snapper from commercial logbook data.

| Year | Relative Nominal CPUE | N | Proportion N Positive | Relative Standardized Index | CV (Index) |
|---|---|---|---|---|---|
| 1993 | 0.885 | 843 | 0.708 | 1.137 | 0.060 |
| 1994 | 0.764 | 1357 | 0.704 | 0.914 | 0.048 |
| 1995 | 0.810 | 1528 | 0.656 | 0.922 | 0.047 |
| 1996 | 0.496 | 1240 | 0.582 | 0.573 | 0.056 |
| 1997 | 0.484 | 1479 | 0.546 | 0.567 | 0.059 |
| 1998 | 0.508 | 1365 | 0.495 | 0.632 | 0.058 |
| 1999 | 0.644 | 1172 | 0.520 | 0.756 | 0.062 |
| 2000 | 0.774 | 1160 | 0.521 | 0.745 | 0.060 |
| 2001 | 1.197 | 1381 | 0.663 | 1.218 | 0.050 |
| 2002 | 1.090 | 1430 | 0.706 | 1.365 | 0.047 |
| 2003 | 1.036 | 1178 | 0.626 | 1.111 | 0.054 |
| 2004 | 1.334 | 1059 | 0.630 | 1.440 | 0.053 |
| 2005 | 1.105 | 1068 | 0.582 | 1.228 | 0.060 |
| 2006 | 0.543 | 950 | 0.483 | 0.608 | 0.068 |
| 2007 | 0.665 | 1123 | 0.477 | 0.664 | 0.066 |
| 2008 | 1.976 | 1013 | 0.560 | 1.201 | 0.068 |
| 2009 | 2.688 | 948 | 0.631 | 1.918 | 0.073 |

**Table 5.4.3.1.** Nominal catch rates of red snapper from private boat MRFSS mode from nearshore and offshore waters from North Carolina through the Atlantic Florida using intercepts selected with the Stephens and MacCall logistic regression.

| Year | N | Mean | CV | Scaled to Mean |
|---|---|---|---|---|
| 1991 | 12 | 0.33 | 0.14 | 0.25 |
| 1992 | 15 | 2.60 | 1.90 | 1.97 |
| 1993 | 16 | 1.06 | 0.29 | 0.81 |
| 1994 | 17 | 1.47 | 0.90 | 1.12 |
| 1995 | 18 | 1.00 | 0.59 | 0.76 |
| 1996 | 12 | 5.25 | 3.84 | 3.98 |
| 1997 | 7 | 4.71 | 3.14 | 3.57 |
| 1998 | 17 | 1.29 | 0.43 | 0.98 |
| 1999 | 71 | 0.80 | 0.20 | 0.61 |
| 2000 | 77 | 0.87 | 0.22 | 0.66 |
| 2001 | 89 | 0.80 | 0.28 | 0.60 |
| 2002 | 64 | 0.91 | 0.23 | 0.69 |
| 2003 | 67 | 1.58 | 0.41 | 1.20 |
| 2004 | 72 | 1.86 | 0.65 | 1.41 |
| 2005 | 38 | 1.95 | 0.76 | 1.48 |
| 2006 | 60 | 1.68 | 0.70 | 1.28 |
| 2007 | 63 | 1.03 | 0.26 | 0.78 |
| 2008 | 73 | 1.34 | 0.27 | 1.02 |
| 2009 | 62 | 1.11 | 0.23 | 0.84 |

**Table 5.4.4.1.** Annual red snapper catch and harvest per unit of effort from SCDNR Charter boat logbook program, 1993 – 2009.

| Year | Vessel Trips | Average Number Anglers per Vessel Trip | Total Catch per Angler Trip | Total Harvest per Angler Trip | % Released | % Vessel Trips With Catch |
|---|---|---|---|---|---|---|
| 1993 | 565 | 4.46 | 0.21 | 0.11 | 45.97 | 17.17 |
| 1994 | 655 | 4.46 | 0.13 | 0.06 | 54.26 | 15.42 |
| 1995 | 531 | 4.43 | 0.08 | 0.04 | 45.26 | 11.86 |
| 1996 | 696 | 4.41 | 0.06 | 0.05 | 11.05 | 8.05 |
| 1997 | 749 | 4.55 | 0.02 | 0.01 | 45.57 | 5.34 |
| 1998 | 903 | 4.39 | 0.10 | 0.06 | 44.61 | 11.96 |
| 1999 | 844 | 4.48 | 0.18 | 0.12 | 32.79 | 17.42 |
| 2000 | 997 | 4.33 | 0.28 | 0.08 | 72.25 | 15.75 |
| 2001 | 980 | 4.42 | 0.42 | 0.14 | 67.72 | 19.08 |
| 2002 | 937 | 4.33 | 0.30 | 0.14 | 53.53 | 17.61 |
| 2003 | 898 | 4.36 | 0.14 | 0.06 | 54.02 | 12.81 |
| 2004 | 1044 | 4.10 | 0.09 | 0.05 | 43.13 | 9.67 |
| 2005 | 1130 | 4.09 | 0.08 | 0.04 | 42.54 | 9.73 |
| 2006 | 1142 | 4.11 | 0.05 | 0.02 | 53.51 | 6.04 |
| 2007 | 1172 | 4.10 | 0.09 | 0.04 | 57.31 | 9.47 |
| 2008 | 1150 | 4.03 | 0.18 | 0.05 | 72.43 | 12.78 |
| 2009 | 867 | 4.10 | 0.19 | 0.07 | 62.39 | 13.73 |

**Table 5.4.4.2.** Nominal CPUE, proportion positive, standardized index and CV for each year for SC charter boat logbooks.

| Year | Relative nominal CPUE | N | Proportion N positive | Standardized index | CV (index) |
|---|---|---|---|---|---|
| 1993 | 1.40 | 75 | 0.33 | 1.55 | 0.22 |
| 1994 | 0.52 | 91 | 0.22 | 0.58 | 0.28 |
| 1995 | 0.57 | 77 | 0.26 | 0.52 | 0.28 |
| 1996 | 0.46 | 105 | 0.28 | 0.52 | 0.21 |
| 1997 | 0.13 | 81 | 0.11 | 0.11 | 0.42 |
| 1998 | 0.96 | 101 | 0.38 | 0.85 | 0.19 |
| 1999 | 2.01 | 105 | 0.52 | 2.14 | 0.17 |
| 2000 | 1.02 | 93 | 0.43 | 0.90 | 0.20 |
| 2001 | 2.57 | 96 | 0.60 | 2.51 | 0.17 |
| 2002 | 2.06 | 108 | 0.54 | 2.07 | 0.16 |
| 2003 | 1.00 | 84 | 0.43 | 0.97 | 0.20 |
| 2004 | 0.83 | 77 | 0.47 | 0.81 | 0.18 |
| 2005 | 0.57 | 81 | 0.30 | 0.72 | 0.24 |
| 2006 | 0.38 | 74 | 0.32 | 0.47 | 0.21 |
| 2007 | 0.63 | 79 | 0.38 | 0.65 | 0.21 |
| 2008 | 0.90 | 100 | 0.39 | 0.72 | 0.20 |
| 2009 | 0.99 | 68 | 0.49 | 0.91 | 0.20 |

**Table 5.5.1.** The standardized CPUE and associated CVs for the recreational headboat fishery and the commercial hook and line fishery.

| Year | Headboat | Headboat (CV) | Commercial Hook and Line | Commercial Hook and Line (CV) |
|---|---|---|---|---|
| 1976 | 2.301 | 0.069 | | |
| 1977 | 2.242 | 0.066 | | |
| 1978 | 2.114 | 0.052 | | |
| 1979 | 2.118 | 0.056 | | |
| 1980 | 1.419 | 0.052 | | |
| 1981 | 2.876 | 0.051 | | |
| 1982 | 1.139 | 0.050 | | |
| 1983 | 1.528 | 0.047 | | |
| 1984 | 1.308 | 0.052 | | |
| 1985 | 1.992 | 0.046 | | |
| 1986 | 0.475 | 0.052 | | |
| 1987 | 0.559 | 0.049 | | |
| 1988 | 0.539 | 0.055 | | |
| 1989 | 0.912 | 0.055 | | |
| 1990 | 0.837 | 0.052 | | |
| 1991 | 0.655 | 0.056 | | |
| 1992 | 0.078 | 0.074 | | |
| 1993 | 0.150 | 0.072 | 1.137 | 0.060 |
| 1994 | 0.259 | 0.066 | 0.914 | 0.048 |
| 1995 | 0.278 | 0.063 | 0.922 | 0.047 |
| 1996 | 0.253 | 0.069 | 0.573 | 0.056 |
| 1997 | 0.266 | 0.080 | 0.567 | 0.059 |
| 1998 | 0.236 | 0.059 | 0.632 | 0.058 |
| 1999 | 0.298 | 0.058 | 0.756 | 0.062 |
| 2000 | 0.418 | 0.061 | 0.745 | 0.060 |
| 2001 | 0.804 | 0.060 | 1.218 | 0.050 |
| 2002 | 0.964 | 0.059 | 1.365 | 0.047 |
| 2003 | 0.531 | 0.065 | 1.111 | 0.054 |
| 2004 | 0.829 | 0.053 | 1.440 | 0.053 |
| 2005 | 0.803 | 0.055 | 1.228 | 0.060 |
| 2006 | 0.454 | 0.062 | 0.608 | 0.068 |
| 2007 | 0.462 | 0.056 | 0.664 | 0.066 |
| 2008 | 1.859 | 0.049 | 1.201 | 0.068 |
| 2009 | 2.043 | 0.046 | 1.918 | 0.073 |

## 5.9 Figures

**Figure 5.3.1.1**. Spatial coverage of Chevron traps over time with yellow circles denoting traps that did not catch red snapper and with red circles denoting traps that did catch red snapper.

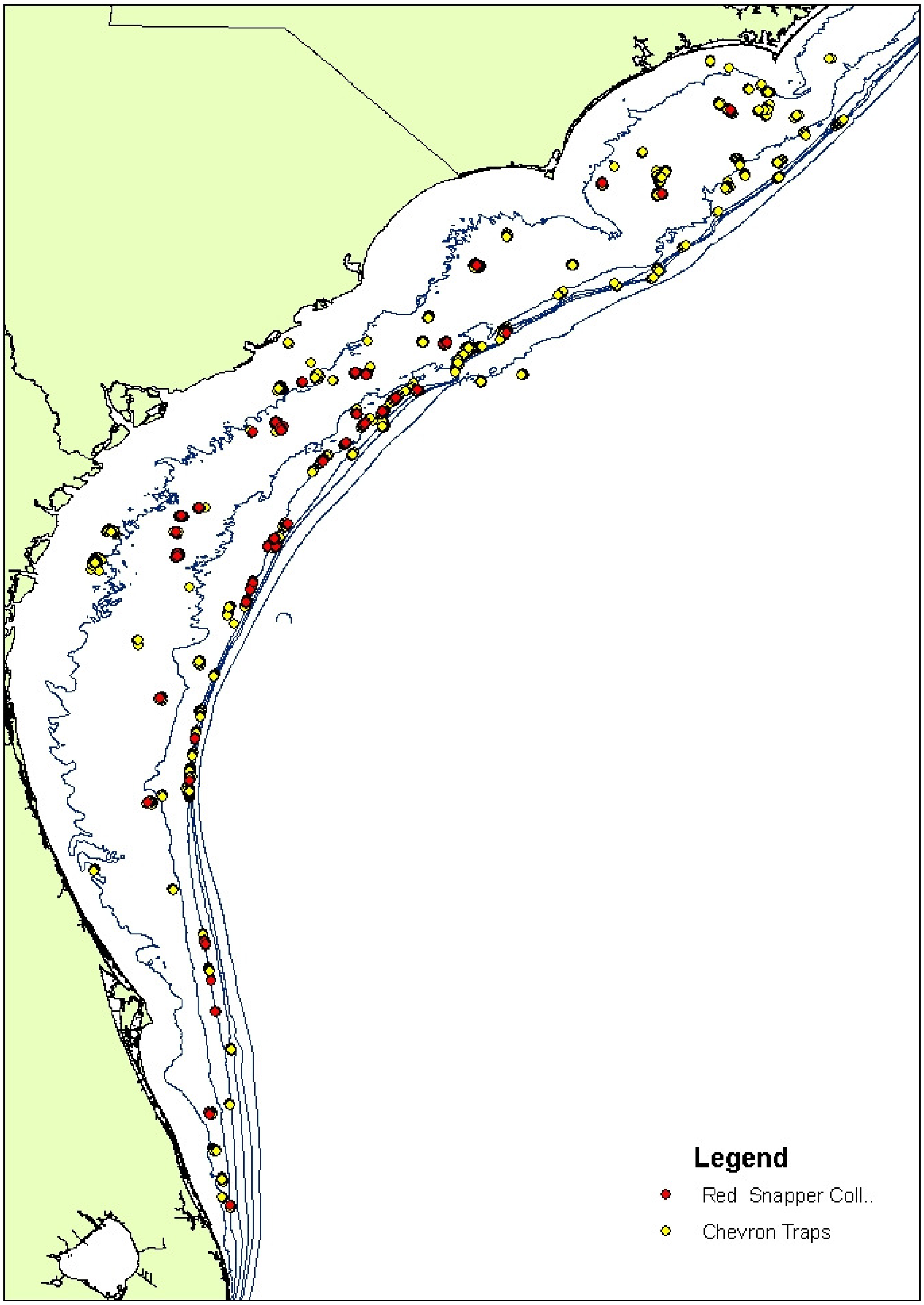


**Figure 5.4.1.1**. Spatial sampling strata from the headboat survey off the southeast Atlantic coast of the U.S. The northern region consisted of areas 2-10, and the southern region consisted of areas 11, 12, and 17.

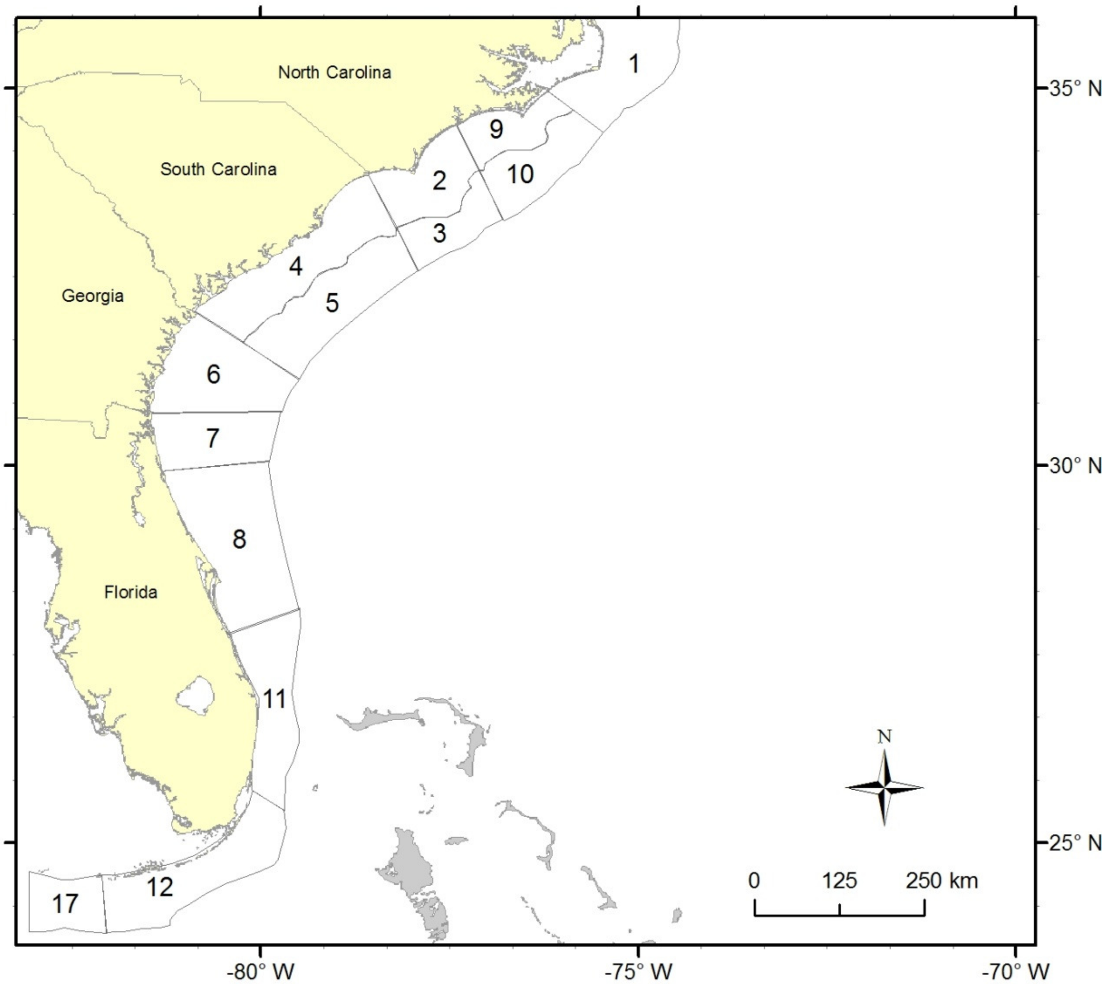


**Figure 5.4.1.2.** The standardized and nominal headboat index computed for red snapper in the south Atlantic during 1976-2009.

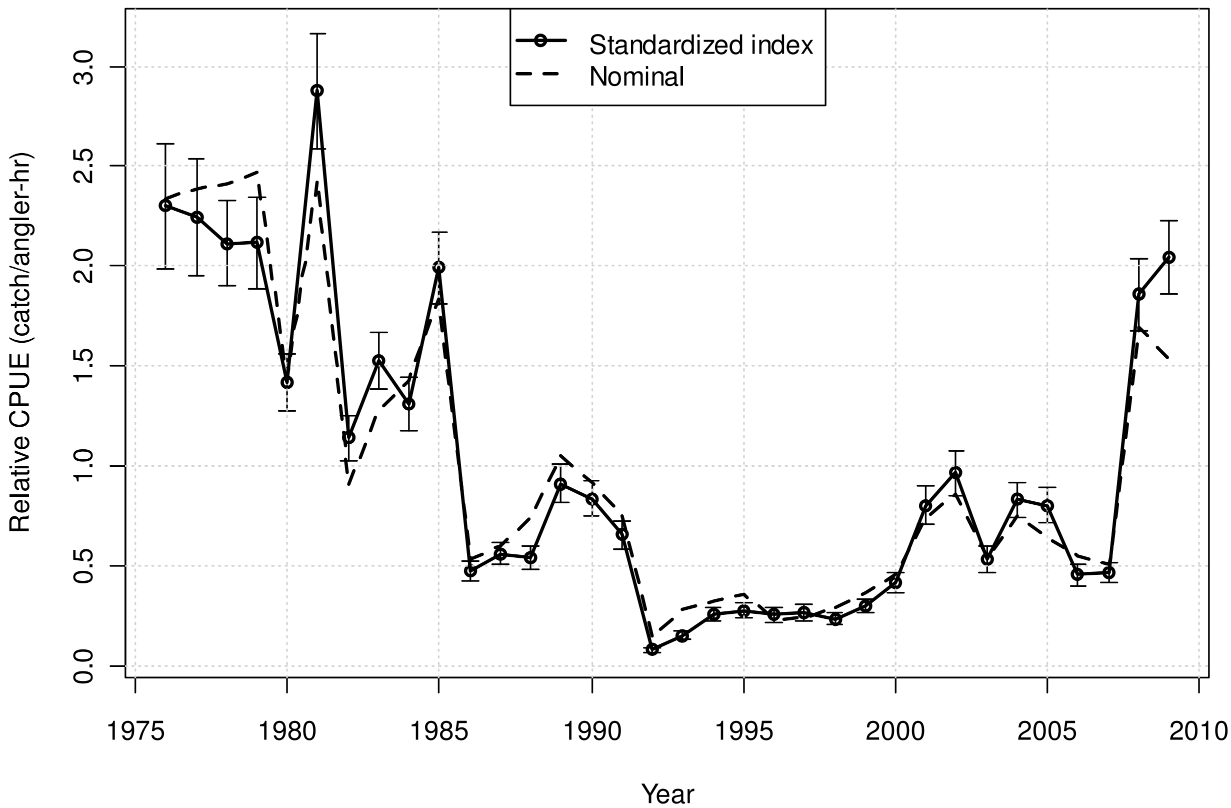


**Figure 5.4.2.1.** Areas reported in commercial logbooks. First two digits signify degrees latitude, second two degrees longitude. Areas were excluded from the analysis if north of 36 degrees latitude or if in the Gulf of Mexico. In analyses, south Florida was treated separately from north Florida, with the boundary occurring at 28 degrees latitude (break near Cape Canaveral; boundary included in the south).

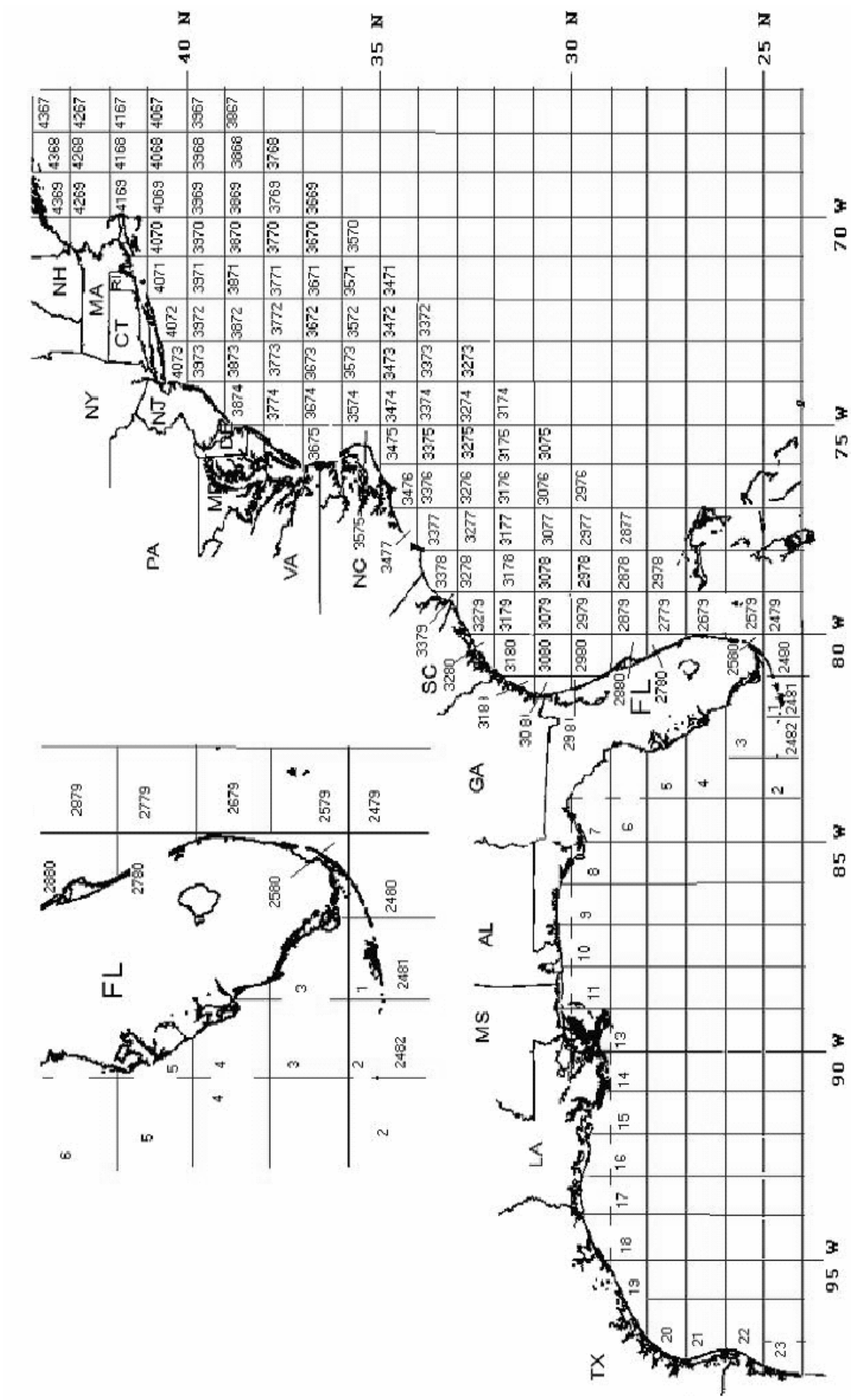


**Figure 5.4.2.2.** Relative standardized index (solid line, black circles, 95% error bars) and relative nominal index (dashed).

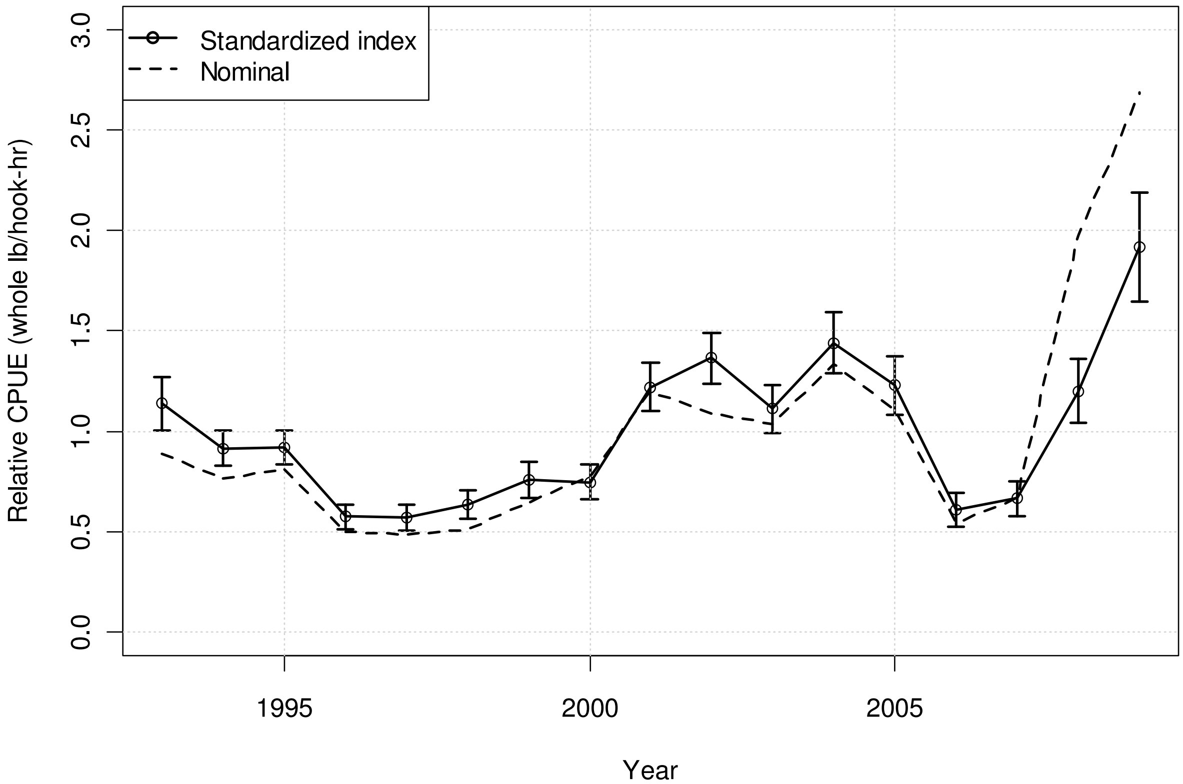


**Figure 5.4.3.1.** Map of the MRFSS/MRIP study area from NC to Miami-Dade County, Florida.

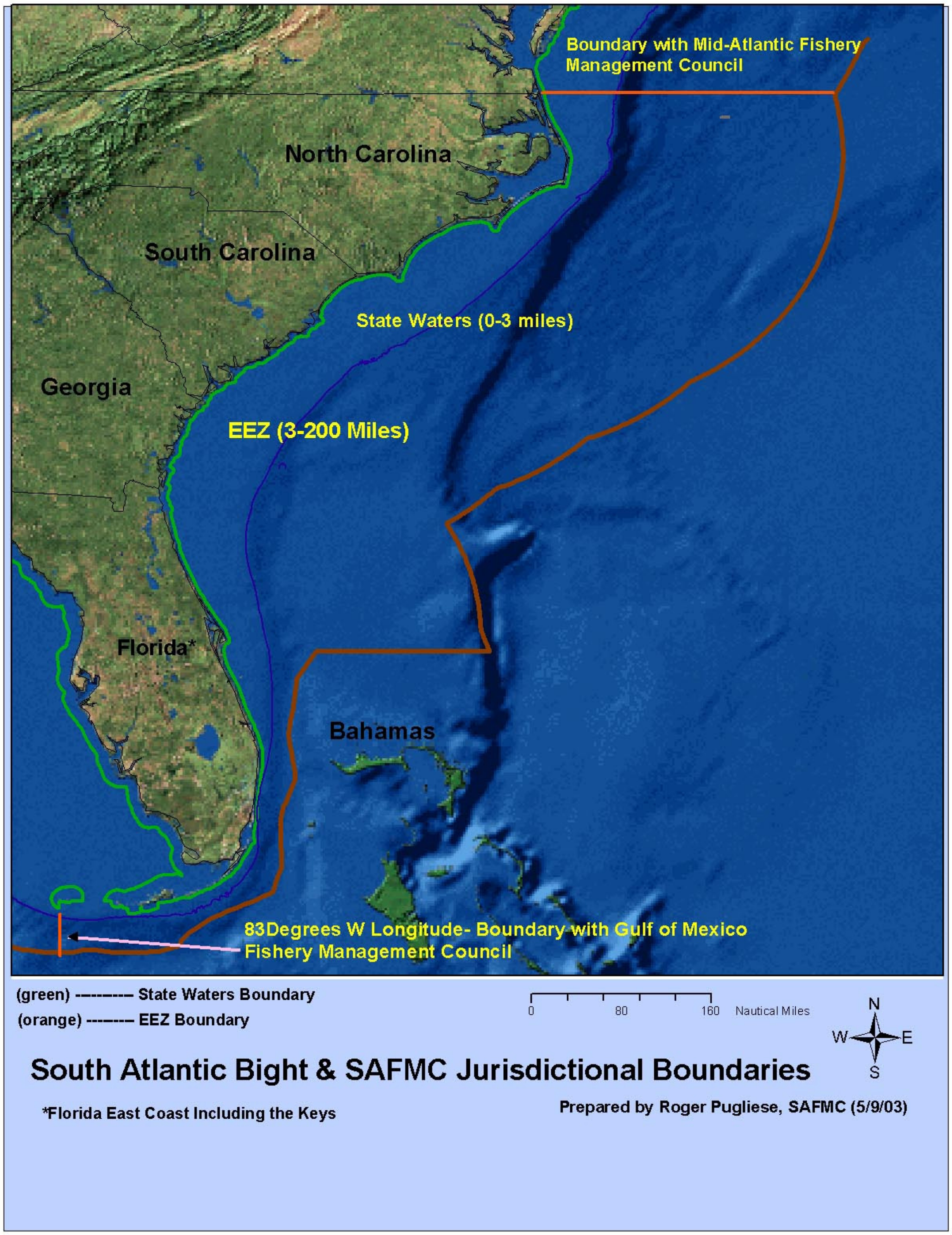


**Figure 5.4.3.2.** Regression coefficients for species selected by the Stephens and MacCall method for the private boat MRFSS/MRIP data.

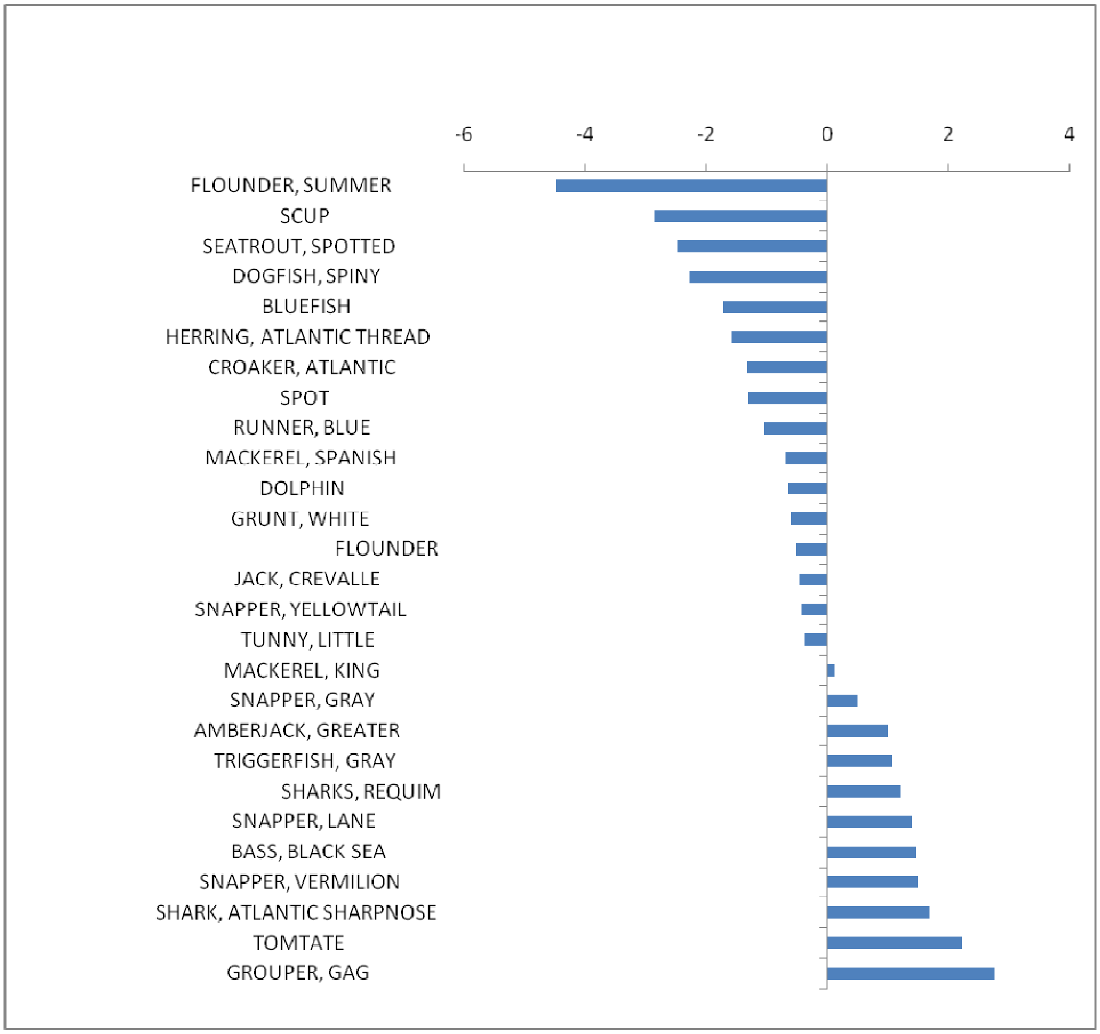


**Figure 5.4.3.3.** Nominal catch rate of red snapper by year from North Carolina to southern Florida. The vertical lines are the 95% confidence interval and the circle is the mean.

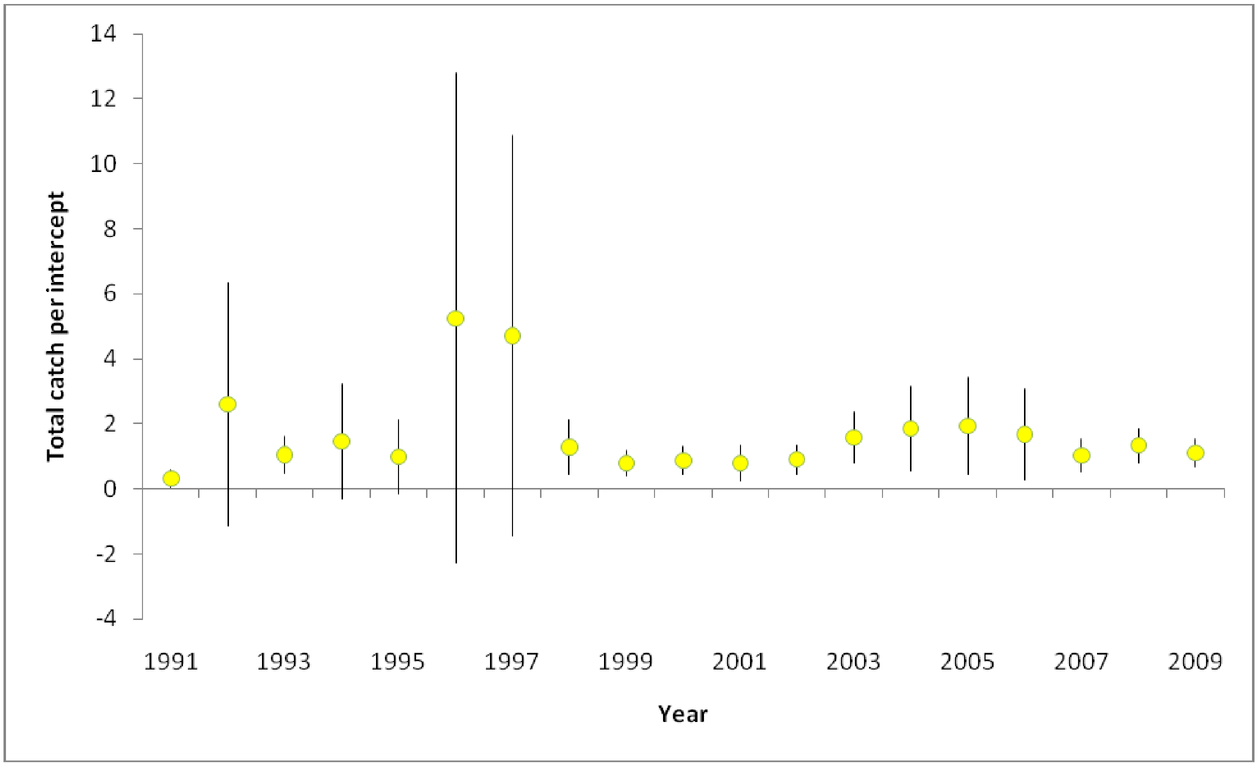
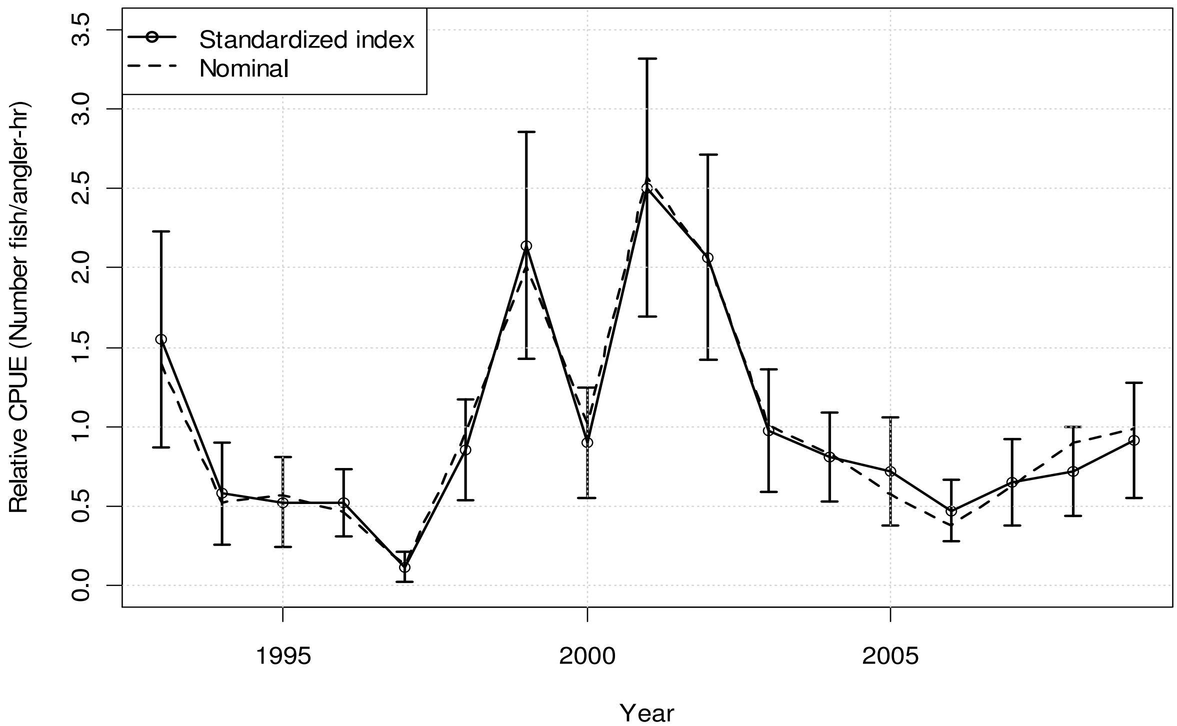
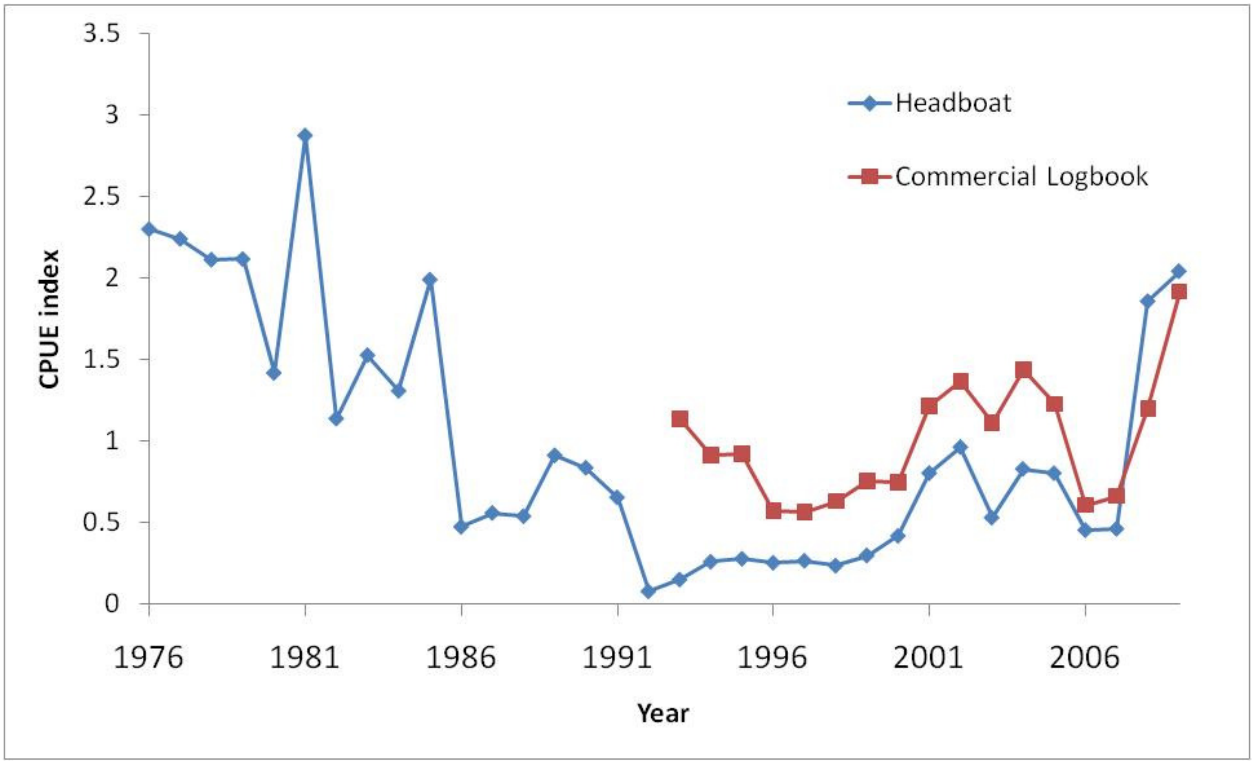



**Figure 5.4.4.1.** Nominal and standardized CPUE for the SC Charter logbook data.



Standardized index
Nominal
Relative CPUE (Number fish/angler-hr)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1995
2000
2005
Year

**Figure 5.5.1**. The standardized CPUE index for the recreational headboat fishery data and the commercial logbook data.



## Section 5 Appendix - Index Report Cards

Review of the usefulness of the report card and some suggestions for improvement:

- Didn't serve the purpose it was intended for: report cards were not filled out prior to the workshop and the Indices group was left to fill out the report card. We didn't find it very useful in making our decisions, thereby filling out the worksheet after the fact.
- If the Indices group is filling out the report card, it would be helpful to have two options: one report card for data not used and one for data used to create an index.
- Groups submitting the report card may not understand many of the requirements, particularly the Model Standardization and Diagnostics sections. An attempt to simplify the report card would be more useful
- The categories of NA, Absent, Incomplete, and Complete were not helpful. Often things were either given or not given. A better explanation or guidance of these categories is needed.
- It is not clear what the minimum requirements are based only on this document. Perhaps it needs to be more cleanly laid out.
- If the report card is filled out prior to the workshop, then the justification is not needed, as the data workgroup will be compiling the justifications for or against the index.
- A checklist clearly listing the minimum data requirements instead of a report card is more worthwhile. This should be the first two sections of the report card (Description of the Data Source and Data reductions sections).

## Appendix 5.1 MARMAP

| DESCRIPTION OF THE DATA SOURCE | Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| **1. Fishery Independent Indices** | | | | | |
| A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling. | | | | X | |
| B. Describe sampling methodology (e.g. gear, vessel, soak time etc.) | | | | X | |
| C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.) | | | | X | |
| D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | | X | |
| E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic). | | | | X | |
| F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | | X | |
| **2. Fishery Dependent Indices** | | | | | |
| A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.). | | | | | |
| B. Describe any changes to reporting requirements, variables reported, etc. | | | | | |
| C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | | | |
| D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | | | |
| **METHODS** | | | | | |
| **1. Data Reduction and Exclusions** | | | | | |
| A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal. | X | | | | |
| B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species | X | | | | |

| | | | | | |
|---|---|---|---|---|---|
| assemblage etc). | | | | | |
| C. Discuss procedures used to identify outliers. How many were identified? Were they excluded? | X | | | | |

| 2. Management Regulations (for FD Indices) | Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.). | X | | | | |
| B. Describe the effects (if any) of management regulations on CPUE | X | | | | |
| C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series. | X | | | | |
| **3. Describe Analysis Dataset (after exclusions and other treatments)** | | | | | |
| A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms. | | | | X | |
| B. Include tables and/or figures of number of positive observations by factors and interaction terms. | X | | | | |
| C. Include tables and/or figures of the proportion positive observations by factors and interaction terms. | X | | | | |
| D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms. | | | | X | |
| E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort). | | | | X | |
| F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection. | X | | | | |
| G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds). | | | | X | |

4. Model Standardization

| | | | | | |
|---|---|---|---|---|---|
| A. Describe model structure (e.g. delta-lognormal) | X | | | | |
| B. Describe construction of GLM components (e.g. forward selection from null etc.) | X | | | | |
| C. Describe inclusion criteria for factors and interactions terms. | X | | | | |
| D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test? | X | | | | |
| E. Provide a table summarizing the construction of the GLM components. | X | | | | |
| F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.) | X | | | | |
| G. Report convergence statistics. | X | | | | |

**MODEL DIAGNOSTICS**

***Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.***

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| 1. Binomial Component | | | | | |
| A. Include plots of the chi-square residuals by factor. | X | | | | |
| B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area) | X | | | | |
| C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | X | | | | |
| 2. Lognormal/Gamma Component | | | | | |
| A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution. | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | X | | | | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | |
| F. Include plots of the residuals by factor | X | | | | |

3. Poisson Component

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | X | | | | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | ***The feasibility of this diagnostic is still under review.*** |

4. Zero-inflated model

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Include ROC curve to quantify goodness of fit. | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor). | X | | | | |
| C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | | |

**MODEL DIAGNOSTICS (CONT.)**

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | |

**MODEL RESULTS**

| | | | | |
|---|---|---|---|---|
| A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report | X | | | |
| B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs). | X | | | |

**IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED**:

(***Note: this is always recommended but required when model diagnostics are poor***.)

| | | | | |
|---|---|---|---|---|
| 1. Plot of resulting indices and estimates of variance | X | | | |
| 2. Table of model statistics (e.g. AIC criteria) | X | | | |

| | ***Date Received*** | ***Workshop Recommendation*** | ***Revision Deadline ****** | ***Author and Rapporteur Signatures*** |
|---|---|---|---|---|
| **First Submission** | 5/26/2010 | Not recommended for use | | |
| **Revision** | | | | |

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author **DOES NOT** commit to any **LEGAL OBLIGATION** by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

***Justification of Working Group Recommendation***

Because of the low catches and high variability in the data, the DW did not recommend using any of the MARMAP samples to develop an index of abundance for red snapper.

## Appendix 5.2 Headboat

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| **DESCRIPTION OF THE DATA SOURCE** | | | | | |
| 1. Fishery Independent Indices | | | | | |
| A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling. | x | | | | |
| B. Describe sampling methodology (e.g. gear, vessel, soak time etc.) | x | | | | |
| C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.) | x | | | | |
| D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | x | | | | |
| E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic). | x | | | | |
| F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | x | | | | |
| 2. Fishery Dependent Indices | | | | | |
| A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.). | | | | x | |
| B. Describe any changes to reporting requirements, variables reported, etc. | | | | x | |
| C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | | x | |
| D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | | x | |
| **METHODS** | | | | | |
| 1. Data Reduction and Exclusions | | | | | |
| A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal. | | | x | | The exact number of records was not reported for each step. |
| B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear | | | | x | |

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| configuration, species assemblage etc). | | | | | |
| C. Discuss procedures used to identify outliers. How many were identified? Were they excluded? | | | | x | |

## 2. Management Regulations (for FD Indices)

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.). | | | | x | Looked at bag limits |
| B. Describe the effects (if any) of management regulations on CPUE | | | | x | |
| C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series. | x | | | | |

## 3. Describe Analysis Dataset (after exclusions and other treatments)

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms. | | | | x | |
| B. Include tables and/or figures of number of positive observations by factors and interaction terms. | | | | x | |
| C. Include tables and/or figures of the proportion positive observations by factors and interaction terms. | | | | x | |
| D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms. | | | | x | |
| E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort). | | | x | | A map of the survey area was provided. A data workshop report contains some maps of most recent years. |
| F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection. | | | | x | |
| G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds). | | | | x | |

## 4. Model Standardization

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Describe model structure (e.g. delta-lognormal) | | | | x | |
| B. Describe construction of GLM components (e.g. | | | | x | |

| | | | | | |
|---|---|---|---|---|---|
| forward selection from null etc.) | | | | | |
| C. Describe inclusion criteria for factors and interactions terms. | | | | x | |
| D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test? | | x | | | |
| E. Provide a table summarizing the construction of the GLM components. | | | | x | |
| F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.) | | | | x | |
| G. Report convergence statistics. | | | x | | |

**MODEL DIAGNOSTICS**

***Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.***

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| 1. Binomial Component | | | | | |
| A. Include plots of the chi-square residuals by factor. | | | | x | |
| B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area) | | | | x | |
| C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | | x | | | |
| 2. Lognormal/Gamma Component | | | | | |
| A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution. | | | | x | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | | | | x | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | | | | x | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | | x | | | |

| Item | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | | x | | | |
| F. Include plots of the residuals by factor | | | | x | |
| **3. Poisson Component** | | | | | |
| A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | x | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | x | | | | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | x | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | x | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | x | | | | ***The feasibility of this diagnostic is still under review.*** |
| **4. Zero-inflated model** | | | | | |
| A. Include ROC curve to quantify goodness of fit. | x | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor). | x | | | | |
| C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution. | x | | | | |

**MODEL DIAGNOSTICS (CONT.)**

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | x | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | x | | | | |

| | | | |
|---|---|---|---|
| | | | |

**MODEL RESULTS**

| | | | | |
|---|---|---|---|---|
| A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report | | | | x |
| B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs). | | | | x |

**IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED**:

(***Note: this is always recommended but required when model diagnostics are poor***.)

| | | | | |
|---|---|---|---|---|
| 1. Plot of resulting indices and estimates of variance | | x | | |
| 2. Table of model statistics (e.g. AIC criteria) | | | | x |

| | ***Date Received*** | ***Workshop Recommendation*** | ***Revision Deadline ****** | ***Author and Rapporteur Signatures*** |
|---|---|---|---|---|
| **First Submission** | 5/26/2010 | Recommended for use | | |
| **Revision** | | | | |

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author* ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

***Justification of Working Group Recommendation***

Much of the information for the HB index can be found in the SEDAR24-DW03 data working paper.

## Appendix 5.3 Commercial Logbook

**DESCRIPTION OF THE DATA SOURCE**

| 1. Fishery Independent Indices | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling. | | | | | |
| B. Describe sampling methodology (e.g. gear, vessel, soak time etc.) | | | | | |
| C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.) | | | | | |
| D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | | | |
| E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic). | | | | | |
| F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | | | |

2. Fishery Dependent Indices

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments |
|---|---|---|---|---|---|
| A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.). | | | | X | |
| B. Describe any changes to reporting requirements, variables reported, etc. | | | | X | |
| C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | | X | |
| D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | | x | |

**METHODS**

1. Data Reduction and Exclusions

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments |
|---|---|---|---|---|---|
| A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records | | | | X | |

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| removed and justify removal. | | | | |
| B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc). | | | | X |
| C. Discuss procedures used to identify outliers. How many were identified? Were they excluded? | | | | x |

**Working Group Comments:**

2. Management Regulations (for FD Indices)

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.). | | X | | |
| B. Describe the effects (if any) of management regulations on CPUE | | X | | |
| C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series. | | X | | |

3. Describe Analysis Dataset (after exclusions and other treatments)

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms. | | | | X |
| B. Include tables and/or figures of number of positive observations by factors and interaction terms. | | | | X |
| C. Include tables and/or figures of the proportion positive observations by factors and interaction terms. | | | | X |
| D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms. | | | | X |
| E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort). | | | X | |
| F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection. | | | | X |
| G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds). | | | | X |

4. Model Standardization

| | | | | |
|---|---|---|---|---|
| A. Describe model structure (e.g. delta-lognormal) | | | | X |
| B. Describe construction of GLM components (e.g. forward selection from null etc.) | | | | X |
| C. Describe inclusion criteria for factors and interactions terms. | | | | X |
| D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test? | | X | | |
| E. Provide a table summarizing the construction of the GLM components. | | | | X |
| F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.) | | | | X |
| G. Report convergence statistics. | | X | | |

**MODEL DIAGNOSTICS**

***Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.***

**Working Group Comments:**

1. Binomial Component

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| A. Include plots of the chi-square residuals by factor. | | | | X |
| B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area) | | | | X |
| C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | | X | | |

2. Lognormal/Gamma Component

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution. | | | | X |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | | | | X |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected | | | | X |

| | | | | | |
|---|---|---|---|---|---|
| distribution. | | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | | X | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | | X | | | |
| F. Include plots of the residuals by factor | | | | X | |

3. Poisson Component

| | | | | | |
|---|---|---|---|---|---|
| A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | X | | | | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | ***The feasibility of this diagnostic is still under review.*** |

4. Zero-inflated model

| | | | | | |
|---|---|---|---|---|---|
| A. Include ROC curve to quantify goodness of fit. | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor). | X | | | | |
| C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | | |

| MODEL DIAGNOSTICS (CONT.) | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | |
| **MODEL RESULTS** | | | | | |
| A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report | | | | X | |
| B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs). | | | | X | |
| **IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED**: (***Note: this is always recommended but required when model diagnostics are poor***.) | | | | | |
| 1. Plot of resulting indices and estimates of variance | | x | | | |
| 2. Table of model statistics (e.g. AIC criteria) | | | | x | |

| | *Date Received* | *Workshop Recommendation* | *Revision Deadline* *** | *Author and Rapporteur Signatures* |
|---|---|---|---|---|
| **First Submission** | 5/26/2010 | Recommended for Use | | |
| **Revision** | | | | |

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author **DOES NOT** commit to any **LEGAL OBLIGATION** by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

***Justification of Working Group Recommendation*** ***None***

## Appendix 5.4 MRFSS/MRIP (private mode only)

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| **DESCRIPTION OF THE DATA SOURCE** | | | | | |
| 1. Fishery Independent Indices | | | | | |
| A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling. | X | | | | |
| B. Describe sampling methodology (e.g. gear, vessel, soak time etc.) | X | | | | |
| C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.) | X | | | | |
| D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | X | | | | |
| E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic). | X | | | | |
| F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | X | | | | |
| 2. Fishery Dependent Indices | | | | | |
| A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.). | | | | X | |
| B. Describe any changes to reporting requirements, variables reported, etc. | | | | X | |
| C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | | X | |
| D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | | X | |
| **METHODS** | | | | | |
| 1. Data Reduction and Exclusions | | | | | |
| A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal. | | | | X | |
| B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc). | | | | X | |
| C. Discuss procedures used to identify outliers. How many were identified? Were they excluded? | | | | X | |

| 2. Management Regulations (for FD Indices) | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.). | | | | X | |
| B. Describe the effects (if any) of management regulations on CPUE | | | | X | |
| C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series. | X | | | | |

3. Describe Analysis Dataset (after exclusions and other treatments)

| | | | | | |
|---|---|---|---|---|---|
| A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms. | | | | X | |
| B. Include tables and/or figures of number of positive observations by factors and interaction terms. | | | | X | |
| C. Include tables and/or figures of the proportion positive observations by factors and interaction terms. | | | | X | |
| D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms. | | | | X | |
| E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort). | X | | | | |
| F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection. | | | | X | |
| G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds). | | | | X | |

4. Model Standardization

| | | | | | |
|---|---|---|---|---|---|
| A. Describe model structure (e.g. delta-lognormal) | | | | X | |
| B. Describe construction of GLM components (e.g. forward selection from null etc.) | | | | X | |
| C. Describe inclusion criteria for factors and interactions terms. | | | | X | |
| D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test? | | | | X | |
| E. Provide a table summarizing the construction of the GLM components. | | | | X | |
| F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.) | | | | X | |
| G. Report convergence statistics. | | | | X | |

**MODEL DIAGNOSTICS**

***Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.***

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| **1. Binomial Component** | | | | | |
| A. Include plots of the chi-square residuals by factor. | X | | | | |
| B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area) | X | | | | |
| C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | X | | | | |
| **2. Lognormal/Gamma Component** | | | | | |
| A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution. | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | X | | | | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | |
| F. Include plots of the residuals by factor | X | | | | |
| **3. Poisson Component** | | | | | |
| A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | X | | | | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | | |

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | ***The feasibility of this diagnostic is still under review.*** |

4. Zero-inflated model

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| A. Include ROC curve to quantify goodness of fit. | X | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor). | X | | | |
| C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | |

**MODEL DIAGNOSTICS (CONT.)**

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | |

**MODEL RESULTS**

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report | | | | X |
| B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs). | | | | X |

**IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED**:

(***Note: this is always recommended but required when model diagnostics are poor***.)

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| 1. Plot of resulting indices and estimates of variance | X | | | |
| 2. Table of model statistics (e.g. AIC criteria) | X | | | |

| | ***Date Received*** | ***Workshop Recommendation*** | ***Revision Deadline*** *** | ***Author and Rapporteur Signatures*** |
|---|---|---|---|---|
| **First Submission** | 5/26/2010 | Not recommended for use | | |
| **Revision** | | | | |

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author* ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

***Justification of Working Group Recommendation***

Given the relatively low sample size, the high variability for a fishery dependent index, and the suspected lack of representation of the fishery, the indices work group does not feel that this index is adequate for the assessment and does not recommend it for inclusion in the model.

## Appendix 5.5 Recreational SC V1 Vessel Logbook Data

**DESCRIPTION OF THE DATA SOURCE**

1. Fishery Independent Indices

| | Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling. | X | | | | |
| B. Describe sampling methodology (e.g. gear, vessel, soak time etc.) | X | | | | |
| C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.) | X | | | | |
| D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | X | | | | |
| E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic). | X | | | | |
| F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | X | | | | |

2. Fishery Dependent Indices

| | Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.). | | | | X | |
| B. Describe any changes to reporting requirements, variables reported, etc. | | | | X | |
| C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | | X | |
| D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | X | | | | |

**METHODS**

1. Data Reduction and Exclusions

| | Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify | | | | X | |

| | | | | | |
|---|---|---|---|---|---|
| removal. | | | | | |
| B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc). | | | | X | |
| C. Discuss procedures used to identify outliers. How many were identified? Were they excluded? | | | | X | |

| 2. Management Regulations (for FD Indices) | Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.). | X | | | | |
| B. Describe the effects (if any) of management regulations on CPUE | X | | | | |
| C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series. | X | | | | |
| **3. Describe Analysis Dataset (after exclusions and other treatments)** | | | | | |
| A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms. | | | | X | |
| B. Include tables and/or figures of number of positive observations by factors and interaction terms. | | | | X | |
| C. Include tables and/or figures of the proportion positive observations by factors and interaction terms. | | | | X | |
| D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms. | | | | X | |
| E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort). | | X | | | |
| F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection. | | | | X | |
| G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, | | | | X | |

| | | | | | |
|---|---|---|---|---|---|
| pounds). | | | | | |
| 4. Model Standardization | | | | | |
| A. Describe model structure (e.g. delta-lognormal) | | | | X | |
| B. Describe construction of GLM components (e.g. forward selection from null etc.) | | | | X | |
| C. Describe inclusion criteria for factors and interactions terms. | X | | | | |
| D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test? | X | | | | |
| E. Provide a table summarizing the construction of the GLM components. | X | | | | |
| F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.) | X | | | | |
| G. Report convergence statistics. | X | | | | |

**MODEL DIAGNOSTICS**

***Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.***

| | **Not Applicable** | **Absent** | **Incomplete** | **Complete** | **Working Group Comments:** |
|---|---|---|---|---|---|
| 1. Binomial Component | | | | | |
| A. Include plots of the chi-square residuals by factor. | X | | | | |
| B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area) | X | | | | |
| C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | X | | | | |
| 2. Lognormal/Gamma Component | | | | | |
| A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution. | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | X | | | | |
| | X | | | | |

| | | | | | |
|---|---|---|---|---|---|
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | |
| F. Include plots of the residuals by factor | X | | | | |
| 3. Poisson Component | | | | | |
| A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | X | | | | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | ***The feasibility of this diagnostic is still under review.*** |
| 4. Zero-inflated model | | | | | |
| A. Include ROC curve to quantify goodness of fit. | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor). | X | | | | |
| C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | | |

**MODEL DIAGNOSTICS (CONT.)**

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | |

**MODEL RESULTS**

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report | | | | X | |
| B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs). | | | | X | |

**IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED**:

(***Note: this is always recommended but required when model diagnostics are poor***.)

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| 1. Plot of resulting indices and estimates of variance | X | | | | |
| 2. Table of model statistics (e.g. AIC criteria) | X | | | | |

| | ***Date Received*** | ***Workshop Recommendation*** | ***Revision Deadline ****** | ***Author and Rapporteur Signatures*** |
|---|---|---|---|---|
| **First Submission** | 5/26/2010 | Not recommended for use | | |
| **Revision** | | | | |

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author* ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

***Justification of Working Group Recommendation***

These data were not recommended for use because they include only one state and therefore, do not cover the entire management area. In addition, the data are potentially included in other reviewed data sets. Finally, data are self-reported and largely unverified.

## Appendix 5.6 Steve Amick Headboat Data

| DESCRIPTION OF THE DATA SOURCE | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| **1. Fishery Independent Indices** | | | | | |
| A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling. | | | | | |
| B. Describe sampling methodology (e.g. gear, vessel, soak time etc.) | | | | | |
| C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.) | | | | | |
| D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | | | |
| E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic). | | | | | |
| F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | | | |
| **2. Fishery Dependent Indices** | | | | | |
| A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.). | | | x | | |
| B. Describe any changes to reporting requirements, variables reported, etc. | | | x | | |
| C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | x | | |
| D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | x | | |
| **METHODS** | | | | | |
| **1. Data Reduction and Exclusions** | | | | | |
| A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal. | | | | | |
| B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc). | | | | | |
| C. Discuss procedures used to identify outliers. How many were identified? Were they excluded? | | | | | |

| 2. Management Regulations (for FD Indices) | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.). | | | | | |
| B. Describe the effects (if any) of management regulations on CPUE | | | | | |
| C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series. | | | | | |

3. Describe Analysis Dataset (after exclusions and other treatments)

| | | | | | |
|---|---|---|---|---|---|
| A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms. | | | | | |
| B. Include tables and/or figures of number of positive observations by factors and interaction terms. | | | | | |
| C. Include tables and/or figures of the proportion positive observations by factors and interaction terms. | | | | | |
| D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms. | | | | | |
| E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort). | | | | | |
| F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection. | | | | | |
| G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds). | | | | | |

4. Model Standardization

| | | | | | |
|---|---|---|---|---|---|
| A. Describe model structure (e.g. delta-lognormal) | | | | | |
| B. Describe construction of GLM components (e.g. forward selection from null etc.) | | | | | |
| C. Describe inclusion criteria for factors and interactions terms. | | | | | |
| D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test? | | | | | |
| E. Provide a table summarizing the construction of the GLM components. | | | | | |
| F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.) | | | | | |
| G. Report convergence statistics. | | | | | |

**MODEL DIAGNOSTICS**

***Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.***

| | Not Applicable | Absent | Incomplete | Complete | **Working Group Comments:** |
|---|---|---|---|---|---|
| **1. Binomial Component** | | | | | |
| A. Include plots of the chi-square residuals by factor. | | | | | |
| B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area) | | | | | |
| C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | | | | | |
| **2. Lognormal/Gamma Component** | | | | | |
| A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution. | | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | | | | | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | | | | | |
| F. Include plots of the residuals by factor | | | | | |
| **3. Poisson Component** | | | | | |
| A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | | | | | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | | | | | ***The feasibility of this diagnostic is still under review.*** |
| **4. Zero-inflated model** | | | | | |
| A. Include ROC curve to quantify goodness of fit. | | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor). | | | | | |
| C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution. | | | | | |

| MODEL DIAGNOSTICS (CONT.) | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | | | | | |
| **MODEL RESULTS** | | | | | |
| A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report | | | | | |
| B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs). | | | | | |
| **IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED**: (***Note: this is always recommended but required when model diagnostics are poor***.) | | | | | |
| 1. Plot of resulting indices and estimates of variance | | | | | |
| 2. Table of model statistics (e.g. AIC criteria) | | | | | |

| | *Date Received* | *Workshop Recommendation* | *Revision Deadline **** | *Author and Rapporteur Signatures* |
|---|---|---|---|---|
| **First Submission** | 5/26/2010 | Not recommended for use | | |
| **Revision** | | | | |

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author* ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

***Justification of Working Group Recommendation***

Captain Steve Amick also presented records of his headboat fishing catch and effort in Georgia from 1983-2009. The overall pattern of this index appeared consistent with the more comprehensive headboat logbook records, which contained the latter portion (1994-2009) of the index. Additionally, the Indices Workgroup was concerned with the limited geographic coverage and the limited sample size (containing only records from one fisherman).

## Appendix 5.7 Commercial Landing Data 1975-1990

### DESCRIPTION OF THE DATA SOURCE

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| **1. Fishery Independent Indices** | | | | | |
| A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling. | | | | | |
| B. Describe sampling methodology (e.g. gear, vessel, soak time etc.) | | | | | |
| C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.) | | | | | |
| D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | | | |
| E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic). | | | | | |
| F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | | | |
| **2. Fishery Dependent Indices** | | | | | |
| A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.). | | | | x | |
| B. Describe any changes to reporting requirements, variables reported, etc. | | | x | | |
| C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | x | | |
| D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | x | | |

### METHODS

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| **1. Data Reduction and Exclusions** | | | | | |
| A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal. | | | | | |
| B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc). | | | | | |
| C. Discuss procedures used to identify outliers. How many were identified? Were they excluded? | | | | | |

| 2. Management Regulations (for FD Indices) | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.). | | | | | |
| B. Describe the effects (if any) of management regulations on CPUE | | | | | |
| C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series. | | | | | |
| **3. Describe Analysis Dataset (after exclusions and other treatments)** | | | | | |
| A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms. | | | | | |
| B. Include tables and/or figures of number of positive observations by factors and interaction terms. | | | | | |
| C. Include tables and/or figures of the proportion positive observations by factors and interaction terms. | | | | | |
| D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms. | | | | | |
| E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort). | | | | | |
| F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection. | | | | | |
| G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds). | | | | | |
| **4. Model Standardization** | | | | | |
| A. Describe model structure (e.g. delta-lognormal) | | | | | |
| B. Describe construction of GLM components (e.g. forward selection from null etc.) | | | | | |
| C. Describe inclusion criteria for factors and interactions terms. | | | | | |
| D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test? | | | | | |
| E. Provide a table summarizing the construction of the GLM components. | | | | | |
| F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.) | | | | | |
| G. Report convergence statistics. | | | | | |

**MODEL DIAGNOSTICS**

***Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.***

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| 1. Binomial Component | | | | | |
| A. Include plots of the chi-square residuals by factor. | | | | | |
| B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area) | | | | | |
| C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | | | | | |
| 2. Lognormal/Gamma Component | | | | | |
| A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution. | | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | | | | | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | | | | | |
| F. Include plots of the residuals by factor | | | | | |
| 3. Poisson Component | | | | | |
| A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | | | | | |
| C. Include QQ-plot – (e.g. Student deviance residuals | | | | | |

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| vs. theoretical quantiles), Overlay expected distribution. | | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | | | | | *The feasibility of this diagnostic is still under review.* |

4. Zero-inflated model

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Include ROC curve to quantify goodness of fit. | | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor). | | | | | |
| C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution. | | | | | |

**MODEL DIAGNOSTICS (CONT.)**

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | | | | | |

**MODEL RESULTS**

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report | | | | | |
| B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs). | | | | | |

**IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED**:

(***Note: this is always recommended but required when model diagnostics are poor***.)

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| 1. Plot of resulting indices and estimates of variance | | | | | |
| 2. Table of model statistics (e.g. AIC criteria) | | | | | |

| | *Date Received* | *Workshop Recommendation* | *Revision Deadline* *** | *Author and Rapporteur Signatures* |
|---|---|---|---|---|
| **First Submission** | 5/26/2010 | Not recommended for use | | |
| **Revision** | | | | |

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author* ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

***Justification of Working Group Recommendation***

South Atlantic landings data from commercial logbooks from 1975-1990 were presented, but no fishing effort was available to compute a CPUE index. The "sampling methodology" and "variables reported" were scored as "incomplete" for these reasons.

## Appendix 5.8 Headboat at Sea Observer Discard Data

**DESCRIPTION OF THE DATA SOURCE**

**Working Group Comments:**

1. Fishery Independent Indices

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling. | | | | |
| B. Describe sampling methodology (e.g. gear, vessel, soak time etc.) | | | | |
| C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.) | | | | |
| D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | | |
| E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic). | | | | |
| F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | | |

2. Fishery Dependent Indices

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.). | | | | x |
| B. Describe any changes to reporting requirements, variables reported, etc. | | | x | |
| C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.). | | | x | |
| D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available. | | | | x |

**METHODS**

1. Data Reduction and Exclusions

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal. | | | X | |
| B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc). | | | X | |
| C. Discuss procedures used to identify outliers. How many | | | X | |

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| were identified? Were they excluded? | | | | | |

2. Management Regulations (for FD Indices)

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.). | | | X | | |
| B. Describe the effects (if any) of management regulations on CPUE | X | | | | |
| C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series. | X | | | | |

3. Describe Analysis Dataset (after exclusions and other treatments)

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms. | | | X | |
| B. Include tables and/or figures of number of positive observations by factors and interaction terms. | | | X | |
| C. Include tables and/or figures of the proportion positive observations by factors and interaction terms. | | | X | |
| D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms. | | | X | |
| E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort). | | | X | |
| F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection. | | | | X |
| G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds). | | | | X |

4. Model Standardization

| | Not Applicable | Absent | Incomplete | Complete |
|---|---|---|---|---|
| A. Describe model structure (e.g. delta-lognormal) | | | X | |
| B. Describe construction of GLM components (e.g. forward selection from null etc.) | | | X | |
| C. Describe inclusion criteria for factors and interactions terms. | | | X | |
| D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test? | | | X | |
| E. Provide a table summarizing the construction of the GLM components. | | | X | |
| F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.) | | | X | |

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| G. Report convergence statistics. | | | X | | |

**MODEL DIAGNOSTICS**

***Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.***

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| 1. Binomial Component | | | | | |
| A. Include plots of the chi-square residuals by factor. | | | X | | |
| B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area) | | | X | | |
| C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | | | X | | |
| 2. Lognormal/Gamma Component | | | | | |
| A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution. | | | X | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | | | X | | |
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | | | X | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | | | X | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | | | X | | |
| F. Include plots of the residuals by factor | | | X | | |
| 3. Poisson Component | | | | | |
| A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom). | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor. | X | | | | |

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | | |
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | ***The feasibility of this diagnostic is still under review.*** |

4. Zero-inflated model

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Include ROC curve to quantify goodness of fit. | X | | | | |
| B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor). | X | | | | |
| C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution. | X | | | | |

**MODEL DIAGNOSTICS (CONT.)**

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution. | X | | | | |
| E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution. | X | | | | |

**MODEL RESULTS**

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report | | | X | | |
| B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs). | | | X | | |

**IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED**:

(***Note: this is always recommended but required when model diagnostics are poor***.)

| | Not Applicable | Absent | Incomplete | Complete | Working Group Comments: |
|---|---|---|---|---|---|
| 1. Plot of resulting indices and estimates of variance | X | | | | |

2. Table of model statistics (e.g. AIC criteria)

| | | | | |
|---|---|---|---|---|
| X | | | | |

| | *Date Received* | *Workshop Recommendation* | *Revision Deadline* *** | *Author and Rapporteur Signatures* |
|---|---|---|---|---|
| **First Submission** | 5/27/2010 | Recommended for use | | |
| **Revision** | | | | |

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author* ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

***Justification of Working Group Recommendation***

At-sea observer sampling of anglers in the headboat fishery was conducted from 2005-2009 in Florida and Georgia, and from 2004-2009 in North and South Carolina. The sampling was predominately located in Florida (and the data available for review at the data workshop was the Florida data), which resulted in a mark of "incomplete" with regard to the sampling design. A nominal CPUE index was computed from the Florida data. Because the observers recorded the number and lengths of all fish caught, this index provides valuable information on both the amount and size composition of the discarded catch. This index could provide information on the relative strengths of young age classes observed by the fishery, and should improve estimates of the headboat size selectivity for the discarded catch. However, a substantial amount of work is required to standardize the index, which resulted in marks of "incomplete" or "not applicable" for most of the items on this spreadsheet. The Indices Workgroup recommends that an attempt be made to standardize the index, and use the nominal CPUE if the standardization cannot be completed in time.

# 6. Discard Mortality

## 6.1 Overview (Membership, Charge)

In preparation for the benchmark assessment, an informal *ad hoc* working group was assembled to advise the Data Workshop Panel on use of the commercial and recreational discard mortalities employed in the SEDAR 15 red snapper benchmark assessment and on their effect on projections during the benchmark.

Members of the *ad hoc* working group were:

Chip Collier - Leader, NC DMF, SAFMC SSC
Jeff Buckle – North Carolina State University
Karen Burns – Gulf of Mexico Fishery Management Council
Kenny Fex - SAFMC SG AP
Robert Johnson - SAFMC SG AP
Stephanie McInerny - NC DMF
Zack Bowen - SAFMC SG AP

The working group's purposes were:

- to make recommendations related to the justification given in the SEDAR 15 benchmark for discard rates used in the benchmark;
- to review any relevant, new research results pertaining to discard mortalities;
- to identify a range of mortality estimates to be used in sensitivities in the red snapper assessment;
- to identify the effect of mortality estimates on projections in the red snapper assessment.

The working group goal was to build a record relating if and why discard mortality rates different from those used in the benchmark should be used in the update, with the recommendations noted above. The group operated via email and conference call. Its work was completed and reported to the panel as a data workshop working paper (SEDAR24-DW12).

In order to deal with the special discard mortality topic during the workshop and in the data workshop report, a more formal DW work group composed of SAFMC-appointed DW panelists was named. Those who served were:

Chip Collier - Leader, NC DMF, SAFMC SSC
Zack Bowen - SAFMC SG AP
Dave Crisp – Recreational fisherman, Florida
Kenny Fex - SAFMC SG AP
Robert Johnson - SAFMC SG AP

Kevin McCarthy - SEFSC, Miami
Stephanie McInerny - Rapporteur, NC DMF
Beverly Sauls - FL FWCC
Kyle Shertzer – SEFSC, Beaufort
Jessica Stephen – SC DNR
Chris Wilson – NC DMF

A plenary session dedicated to the discards mortality topic reviewed SEDAR24-DW12 and developed recommendations for discard mortality to be employed by Data Panel work groups in determination of mortality rates to be recommended to the Assessment Panel.

## 6.2 Discussion

Discard mortality is an important estimation included in stock assessments and should be considered in evaluating the effectiveness of regulatory actions to reduce harvest. Several studies have been conducted to estimate a discard mortality rate for red snapper with values varying from 1 to 93% (Table 1). Most of these studies have focused on red snapper in the Gulf of Mexico where the commercial red snapper fishery operates much differently from the snapper grouper fishery off the US South Atlantic both in depths fished and gear used to target red snapper. The estimates of discard mortality used in SEDAR 15 were 90% for the commercial fishery and 40% for the recreational fishery. The recreational estimate (40%) matched the discard mortality estimate for red snapper from the Gulf of Mexico for fish caught in waters deeper than 20 meters (SEDAR 7). A formal working paper (SEDAR 24 DW 12) was developed for SEDAR 24 and includes a more in depth discussion of discard mortality.

Several studies have focused on depth as an important factor in determining discard mortality due to the visible impact of barotrauma. Studies conducted in depth of less than 35 meters (115 feet) estimated discard mortality rates of 20% or less (Parker 1985, Render and Wilson 1994, Patterson et al. 2002, Burns et al. 2006). Studies conducted in greater than 35 meters generally estimated higher discard mortality rates ranging from 17% to 93% (Gitschlag and Renaud 1994, Burns et al. 2004, Nieland et al. 2007, Burns 2009, Diamond and Campbell 2009, Stephen and Harris 2009). This increase in discard mortality rate with increasing depth is an expected result and has been described for red snapper and other snapper grouper species (Patterson et al. 2001, Burns et al. 2002, Patterson et al. 2002, Rudershausen et al. 2007, Stephen and Harris 2009).

To account for increasing discard mortality rate with increasing depth, three models were investigated to describe these depth effects (Figure 1). Two of the models (Burns et al. 2002, Diamond et al. unpublished data) used a logistic regression function to model the mortality rate and one used a linear trend (Nieland et al. 2007). All three of the models had overlap in the estimation of discard mortality particularly between 50 and 90 meters (see SEDAR 24 DW 12 reference for plots). The linear model had a higher discard mortality rate for red snapper caught in depths less than 40 meters than the other two studies (Nieland et al. 2007). This was likely due to the commercial fishing practices they observed in the GOM. These fishermen were fishing with bandit fishing reels with terminal gear consisting of 20 hooks spread over 4.5 to 6 meters (S. Baker, Jr, personal communication). Typical recreational fishermen in the South Atlantic and GOM as well as commercial fishermen in the South Atlantic fish for snapper/grouper species with terminal gear having less than 5 hooks (Gulf and South Atlantic

Fisheries Foundation 2008). The other two models describing discard mortality also included delayed discard mortality in their discard mortality estimate. Koenig (Burns et al. 2002) used a cage study to determine the effects of depth on red snapper. Additionally, red snapper and gag grouper data were combined in the model since there was no significant difference in the percent mortality at depth. The Diamond et al. (unpublished) combined data from several different studies including the Burns et al. (2002) and Nieland et al. (2007). The discard mortality curves from these two studies were similar with less than 20% discard mortality for fish caught in less than 20 meters increasing to 100% mortality for fish caught in greater than 90 meters.

Hooking related injuries are also important when trying to determine discard mortality (Rummer 2007, Burns et al. 2008). Necropsy results from headboat caught fish showed red snapper suffered greatest from acute hook trauma (49.1%), almost equaling all other sources (50.9%) of red snapper mortality combined in the headboat fishery in waters less than 42 meters (Burns et al. 2008). These hook related injuries caused both immediate and delayed mortality in red snapper. The delayed mortality was a result of the hook nicking an internal organ. This caused the fish to slowly bleed internally eventually leading to death after a few days (Burns et al. 2004). Circle hooks are generally thought to reduce discard mortality rate for red snapper (SEDAR 7; Rummer 2007); however, Burns et al. (2004) did not observe decreased discard mortality rate when comparing recapture rates of red snapper caught on circle and j-hooks.

Additional factors that influence discard mortality rate, such as size of the fish, temperature, and predation, have been considered for red snapper but currently data is too limited to include these parameters in a quantifiable estimation of discard mortality. However it appears smaller red snapper generally survive better than larger red snapper (Patterson et al. 2002).

Temperature has been noted in some studies as a significant factor determining discard mortality rate for red snapper (Render and Wilson 1994, Rummer 2007, Diamond and Campbell 2009). In these studies, the discard mortality rate increased with increasing temperature. More importantly, both Rummer (2007) and Diamond and Campbell (2009) found the temperature differential between surface and bottom water was more important in determining the discard mortality rate than water temperature alone. A greater differential between the surface and bottom temperature will cause a higher discard mortality rate.

Red snapper are preyed upon by several different species including barracuda, sharks, and amberjack (Parker 1985). Dolphins have been listed as a predator in the Gulf of Mexico but this behavior has not been observed in the South Atlantic. In the South Atlantic, the predators of red snapper are generally present during months when water temperatures are warmer (personal communication with commercial fishermen).

## 6.3 Recommendations

### 6.3.1 Use discard mortality estimate based on immediate or delayed mortality

The DW recommended using delayed mortality since this would be a better estimate of discard mortality. Immediate mortality is easier to quantify and can be observed at the surface but this value is unlikely to be an accurate estimate of discard mortality for red snapper. Delayed mortality is able to incorporate mortality due to hook related injuries, predation, and barotraumas that are not observed at the surface or on board boats. The group felt that delayed mortality rate was more appropriate to describe the fate of discarded red snapper.

### 6.3.2 Use a point estimate of discard mortality or use a discard mortality model that included depth as a factor.

The DW recommended using a discard mortality model since depth is an important factor in determining discard mortality rate. Some of the participants mentioned that few fish die in the shallow water typically fished for red snapper. The plenary decided on using the depth model presented in Burns et al. 2002 to estimate discard mortality. The model was selected due to differences in predation in the Gulf of Mexico (dolphin) and South Atlantic, differences in commercial gear in the Gulf of Mexico (rally rig) and South Atlantic (usually less than 5 hooks), and likely differences in temperature between Gulf of Mexico and South Atlantic.

### 6.3.3 How should fishing effort/catch of red snapper by depth be combined with depth-varying discard mortality rates?

The DW recommended integrating the fishing effort and catch of red snapper with the depth-varying discard mortality rate to determine the mean discard mortality. This method is able to use data collected from the different fishing sectors (commercial, private boat, charter and head boat) to describe the average depth of trips that collected red snapper. Different sources of information were analyzed including logbook and observer data. Depth information was analyzed for the commercial fishery for all trips that caught red snapper, trips that landed over 100 pounds of red snapper, and observer data where red snapper were observed. The commercial workgroup recommended using the observer data from the Gulf and South Atlantic Observer study (2008) since this study had depth information combined with catch information. The discard mortality rate estimate of the commercial fishery was 49%. The headboat at sea observer program and logbook data was used to estimate the headboat and charter boat depth distribution. The discard mortality rate estimate for these two sectors was 41.3%. Private boat depth data was very limited but used depth information from South Carolina DNR tagging study and depths recorded from biological samples from Florida and Georgia fishermen. The private boat discard mortality rate estimate was 38.8%. More information on the discard mortality rates by sector can be found in the commercial and recreational section.

### 6.3.4 Range of discard mortality rates to be used in the assessment for uncertainty estimates.

The DW recommended using a range of discard mortality rates to estimate uncertainty in the parameter estimates. The group recommended using the 95% confidence interval based on the Burns et al. 2002 model as opposed to a range based on a certain percentage of the discard mortality estimate (ex. +/- 50% of the discard mortality rate estimate). The group felt that the 95% confidence interval should represent uncertainty in the model and was based on empirical data. It was pointed out the uncertainty represented by this estimate was only based on the discard mortality rate estimate and did not include uncertainty around the depth distribution of discarded red snapper.

### 6.3.5 Sensitivity runs should include an estimate of discard mortality based on doubling the upper bound of the confidence interval for the commercial and recreational discard mortality estimate.

The DW recommended using this estimate for sensitivity runs to determine the overall influence of the discard mortality rate on the model output. The doubling of the upper bound of the discard mortality rate estimate was selected because many of the discard mortality studies underestimate the delayed mortality a species is likely to experience. The studies may limit the influence of predation, handling stress, or gear related issues. Some members felt that the current estimate derived from the Burns et al. 2002 model may be too high but these concerns were based on surface observations. A doubling of the discard mortality rate estimate for commercial and recreational fisheries was discussed as a sensitivity run but this estimate was determined to be too extreme and may be biased.

## 6.4 Research Recommendations

- More hooking, size, and depth related discard mortality studies
- Angler education
- More accurate depths by species from logbooks
- Survey of fishermen and scientists to possibly get information on depth of areas fished and species abundance
- More species specific depth information collected by port agents

## 6.5 Itemized list of tasks for completion following workshop

See Section 1.5

## 6.6 Literature Cited

## 6.8 Tables

**Table 1.** Red snapper discard mortality studies, fishing sector, type of study, gear used in study, sample size (N), depth range of the study, and mortality type reported. Type of study includes a literature search (lit), laboratory (L), surface observation (S), cage study (C), metadata (M) and tagging study (T). Gears include hook and line gears and bandit reels. Mortality rates were separated into surface mortality, delayed mortality, and total mortality.

| | | | | | | | Depth Range | | Mortality Type | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Research Documents | Year | Sector | Area | Type | Gear | N | Meters (range) | Feet | Surface | Delayed | Total |
| Parker | 1985 | | GOM/SA | L S C | H&L | 44 | 30 | | | 11-12% | |
| Parker | 1991 | | GOM/SA | Lit | | | | | | | |
| Gitschlag and Renaud* | 1994 | Rec | GOM | C | H&L | 55 | 50 | 164 | | 36% | |
| Gitschlag and Renaud* | 1994 | Rec | GOM | S | H&L | 232 | 21-40 | 69-131 | 1-44% | | |
| Render and Wilson | 1994 | Rec | GOM | C | H&L | 282 | 21 | 69 | | 20% | |
| Burns et al. | 2002 | Rec | GOM/SA | S C | H&L | | | | See Figure 1 | | |
| Patterson et al. | 2002 | Rec | GOM | T S | H&L | 2,232 | 21-32 | 69-105 | 14% | | |
| Burns et al. | 2004 | Rec | GOM/SA | L S C | H&L | | 0-61.3+ | 0-201 | | | 64% |
| Rummer and Bennett | 2005 | | GOM | L | | | 0-110 | 0- 361 | | | 25-90% |
| Burns et al. | 2006 | Rec | GOM/SA | T S | H&L | 590 | 0-30.8+ | 0-101 | 12% | | |
| Nieland et al. | 2007 | Com | GOM | S | Bandit | 2,900 | 43 (9-83) | 141 | 69% | | |
| Burns et al. | 2008 | Rec | GOM/SA | L T S | H&L | 5,317 | 10.4-42.7 | 34-140 | | | |
| Burns | 2009 | Rec | GOM/SA | L T S | H&L | 1,259 | 10.4-42.7 | 34-140 | 13.60% | 57% | |
| Diamond and Campbell | 2009 | Rec | GOM | C | H&L | 320 | 30, 40, 50 | 98, 131, 164 | 17% | 64% | |
| Stephen and Harris | 2009 | Com | SA | S | Bandit | 67 | 50-70 (20-300) | 164-230 | 93% | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Diamond et al. (unpubl) | | Both | GOM/SA | M | | | | See Figure 1 |

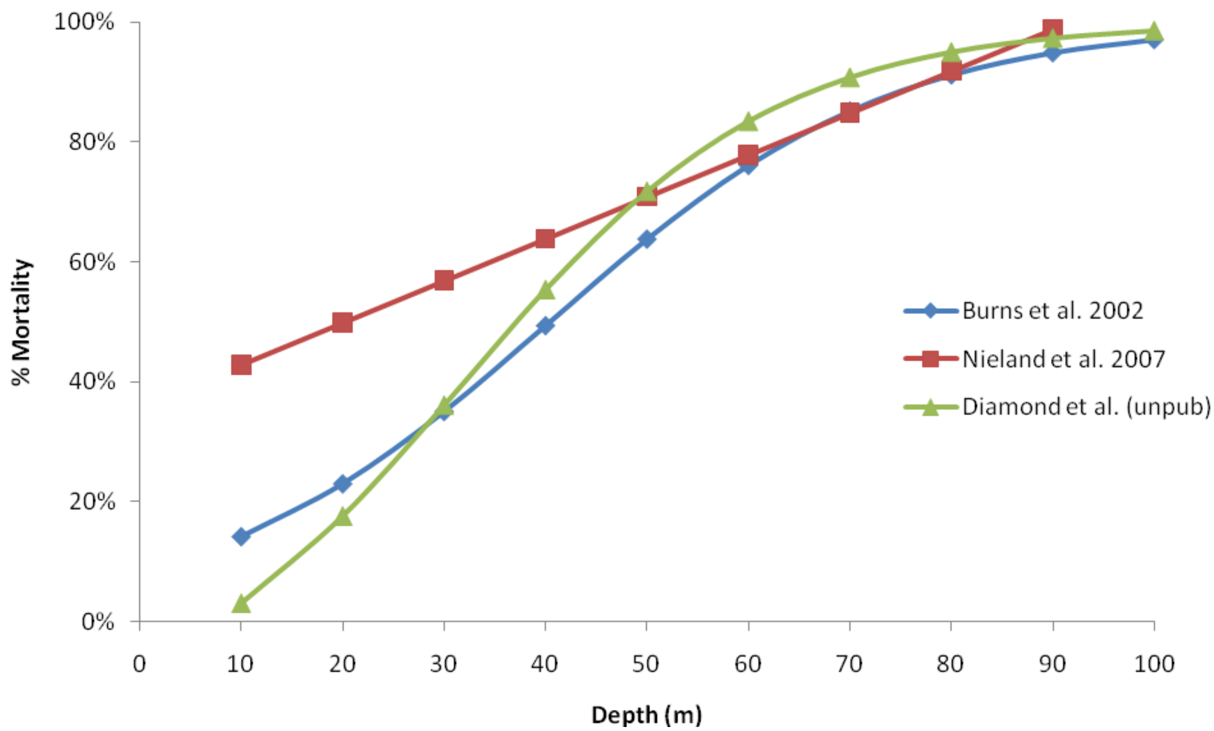
**Table 1. continued**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Assessments | | | | | | | | |
| Manooch et al. | 1998 | Both | SA | Lit | All | All | | 10-25% |
| SEDAR 7 | 2005 | Com | GOM | Lit | All | 50-80+ | | 71-88% |
| SEDAR 7 | 2005 | Rec | GOM | Lit | All | 20-40+ | | 15-40% |
| SEDAR 15 | 2009 | Com | SA | Lit | All | 43-71 (18-823) | 141-233 | 90% |
| SEDAR 15 | 2009 | Rec | SA | Lit | All | 43-58 (20-274) | 141-190 | 40% |

*Same paper

## 6.9 Figures

**Figure 1.** Discard mortality functions by depth (m) for red snapper derived from Burns et al. (2002), Nieland et al. (2007), and Diamond et al (unpublished data).



# 7 Analytic Approach

## 7.1 Overview

Group membership consisted of Brian Linton, Amy Schueller, Kyle Shertzer (leader), Paul Spencer, and Jessica Stephen. The group discussed possible assessment approaches, given the data sources presented at the DW. Our suggestions should not be considered directives, as assessment modeling decisions are the purview of the assessment workshop.

## 7.2 Suggested Analytic Approach Given the Data

The group suggested that a statistical catch-age model, such as the Beaufort Assessment Model (BAM), be considered. The BAM can accommodate the various sources of data discussed (landings, discards, indices, length compositions, and age compositions), and is flexible enough to include many of the details specific to this red snapper stock. Other models that could be considered, perhaps as supplemental, are stock reduction analysis and surplus production models.

# 8. Research Recommendations

Workshop Term of Reference #10 called for the Data Panel to provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment; and to include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage.

## 8.1 Life History

### 8.1.1 Age Reading Comparisons

Continuing the age reading comparisons and calibrations between labs on a reference collection of known age fish would be beneficial for determining a more accurate aging error matrix and would provide accuracy to the age composition data.

### 8.1.2 Movements and Migrations

More research on red snapper movements/migrations in Atlantic waters is needed. Available data and the results of studies in the Gulf of Mexico indicate high site fidelity. Tropical storms may cause greater than normal movement.

## 8.2 Commercial Statistics

### 8.2.1 Decision 10 of the Commercial Statistics Work Group.

The Workgroup reviewed recommendations from SEDAR 15 and offers additional recommendations.
First, the Commercial WG notes that Sea Grant is currently funding a video monitoring program for observing the snapper-grouper fishery using exemption permits with 7 total vessels participating (1 in NC, 2 each in SC, GA, and FL).

The Commercial WG recommended the following:

- Electronic Logbooks
- More observers
    - 5-10% allocated by strata within states
    - Possible to use exemption to bring in everything with no sale
    - Get maximum information from fish
- Angler education with regards to recording depths on paper logbooks
- More precise depths by species from port agents (would require data base change)
- Expand TIP sampling
    - Reallocate samplers for at-sea observer trips
    - Improve sampling from Florida's handline and dive gear where most of the effort and landings are from.
- Continue to sample more ages (proportional to effort), although large numbers of ages were sampled in the most recent years, especially 2009.

These recommendations were approved by the plenary.

## 8.3 Recreational Statistics

The research recommendations of the Recreational Work Group are:

- In order to separate PR and CH catch data, more age data are needed, particularly from the PR mode.
- Continued research efforts to incorporate/require logbook reporting from recreational anglers.
- Quantify historical fishing photos for use in future SEDARS.
- MRFSS At-SEA observer program in NC, SC and GA should collect depth fished data. Standardize data elements within this program.
- Headboat Survey logbook should also collect depth information.
- Continued research efforts to collect discard length and age data from the private sector.
- Improve metadata collection in the recreational fishery.

## 8.4 Indices

The research recommendations of the Indices Work Group are:

- More fishery independent data collection
- Exploration of the Stephens and MacCall trip selection method and alternatives methods
  - Explore the use of actual landings rather than presence/absence for other species for trip selection
- Evaluate how fishermen preferences change over time and whether such changes affect CPUE
- Increase observer coverage, including information on area fished and depth
- Examine how catchability has changed over time with increases in technology and potential changes in fishing practices. This is of particular importance when considering fishery dependent indices
- Investigate potential density-dependent changes in catchability

## 8.5 Analytic Approach

There are no research recommendations from the Analytic Approach working group.

## 8.6 Discards Mortality

The research recommendations of the Discards Mortality Work Group are:

- More hooking, size, and depth related discard mortality studies
- Angler education
- More accurate depths by species from logbooks
- Survey of fishermen and scientists to possibly get information on depth of areas fished and species abundance
- More species specific depth information collected by port agents

# 9. Submitted Comment from Appointed Panelists

## 9.1 Fishery-dependent and fishery-independent data collection programs

### 9.1.1 Inquiry on May 24 by Gregg Waugh, SAFMC Staff

What document or documents describe the current fishery-dependent and fishery-independent data collection programs? I have looked at SEDAR24-RD56 which provides a general description of the headboat survey program and SEDAR24-DW08 which provides a general description of the TIP program. However, neither of these describe the specific target sampling levels for red snapper.

### 9.1.2 Reply on May 24 by Marcel Reichert, MARMAP

MARMAP's annual cruise reports (as submitted to the NMFS, normally at the end of November each year) describe the methods and efforts for our sampling, plus an overview of collected and processed species. In addition, our status of the stocks reports have described methods and some analyses of our data for a selected group of species.

To address the question about "target levels"; MARMAP is charged with sampling (natural live bottom) habitat and we do not "set targets" for any particular species. Having said that, due to the recently added SEAMAP funding we are now trying to expand our sampling areas. Within that effort we are specifically looking for areas that are known to have yielded red snapper in the past.

### 9.1.3 Reply on May 28 by Erik Williams, SEFSC, NMFS, Beaufort

**South Atlantic Fishery Independent Monitoring Program (SAFIMP) update**

**1 June 2010**

In 2010, efforts will focus on three main components:

**Component 1: MARMAP supplement and new gear introduction**

*Need addressed:* The purpose of this component is to add a second survey vessel (in addition to the MARMAP vessel *RV Palmetto*) to supplement MARMAP fishery-independent sampling efforts in southeast US continental shelf waters. Surveys on the second vessel will utilize general MARMAP methodologies (but see below), *resulting in increased sample size and spatial coverage (and thus statistical power) of fishery-independent surveys*, with related increases in otolith and gonad samples, addressing data needs for multiple species. Video camera gear will be tested and, once a suitable deployment methodology is established, incorporated into surveys to address current gear selectivity issues associated with the main MARMAP survey gear (chevron traps). In 2010, the second survey vessel will focus surveys in areas off of GA and northeastern FL to provide as much data as possible for red snapper.

**Component 2: Assessing red snapper abundance and age structure in shelf-break waters**

*Need addressed:* This component will involve a partnership with industry (i.e., use of commercial vessels and gear) to address the following questions: (1) is there a "cryptic biomass" of red snapper in continental shelf-break waters (referred to by commercial fishers as the "roll-down") off of GA and northeastern FL that is comprised of older and larger individuals than exist in continental shelf waters, and, if so, (2) what proportion of the overall stock (continental shelf plus roll-down) does this cryptic biomass represent? Bottom longline sampling from contracted commercial vessels will be replicated across three depth zones (< 16 fathoms, 16-27 fathoms and 27-100 fathoms, with focus in the last depth zone on depths ~ 35-50 fathoms) in areas off GA and northeastern FL. This project will be supplemented by remotely operated vehicle (ROV) surveys of shelf-break waters to further assess red snapper abundance in those waters (see Component 3).

**Component 3: Research to assess and improve sampling program efficiency and power**

*Need addressed:* Research cruises aboard the *NOAA Ship Pisces* will focusing on (1) the assessment of spatial variability in red snapper habitat distribution and abundance, including ROV surveys in shelf-break waters and multi-gear surveys to identify red snapper juvenile habitat, (2) comparative analysis of fish traps, video cameras, and acoustics for fishery-independent data collection, and (3) bathymetric data collection (for subsequent habitat mapping) over hardbottom habitats. As with Components 1 and 2, in 2010 *Pisces* cruise efforts will occur predominantly in areas off of northern FL and GA to provide as much data as possible for red snapper.

## 9.2 Red Snapper depth ranges for the Cape Canaveral to St. Augustine region and north to South Carolina – Rusty Hudson

Historically I have personally caught Red Snapper of all sizes from depths of 60 feet in the near shore areas, offshore to 200 feet on both commercial & the for-hire vessels and caught predominately large Red Snapper from 200 to 300 feet of water commercially. I have fished spawning aggregations of large Red Snapper in depths from 60 feet to 110 feet that occur in the summer months in my home region offshore of Volusia County, Florida. Most of the for-hire fishing on head boats and charter boats bottom fishing has occurred on popular reefs found in 60 feet of depth out to 90 feet of depth.

I have fished the "Big Ledge" or Continental shelf that occurs at 165 feet on top of the ledge and drops to about 200 feet on the bottom side from South Florida, North to the Carolinas. I have fished this area since the 1970's and caught a lot of Red Snapper. The Big Ledge is found about 30 miles offshore of the Cape Canaveral area and up to 80 miles or more from the beach from North Florida up to the South Carolina region.

Offshore of the Big Ledge from South of Cape Canaveral North to offshore of Daytona Beach are natural features called "The Steeples" usually 40 feet in height up to 75 feet that are found usually at 240 feet of depth and offshore to 300 feet in depth. The Red Snapper found there are usually very large animals that range from 20 pounds to 40 pounds whole weight.

## 9.3 Summary of SEDAR24-RD57 – Frank Hester

Biological-Statistical Census of the Species Entering Fisheries in the Cape Canaveral Area, SSR-Fisheries No. 514 by William W Anderson and Jack W. Gerhinger, 79 pp

Area covered: From Melbourne to North of Ponce de Leon Inlet to 29º N.

Recreational Fishery 1962 and 1963 and Commercial 4-year Average

| Fishery | year | Catch Wt. | Catch # | Avg.Wt. | Method |
|---|---|---|---|---|---|
| Sport | 1962 | 302,987 | 78,239 | 5.02 | Field survey* |
| Commercial | 1959-62 | 251,475** | NA | NA | 4-yr. average of landing records |
| Sport | 1963 | 101,426 | 12,779 | 7.93 | Field survey |

# Appendix A

# Observer Report – NOAA Center for Independent Experts